# Department of Transportation

# Federal Aviation Administration

System Specification

# Ground-Based Transceiver (GBT)
# For
# Broadcast Services
# Using the Universal Access Transceiver (UAT) Data Link

**FAA-E-2973**

08/08/03

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# 1.0 SCOPE AND BACKGROUND

This document is the subsystem specification for the Ground Based Transceiver (GBT). The fundamental role of the GBT is to support broadcast data link services. These services are known as Automatic Dependent Surveillance-Broadcast (ADS-B), Traffic Information Services-Broadcast (TIS-B) and Flight Information Services-Broadcast (FIS-B).

## 1.1 Broadcast Data Link Services

### 1.1.1 ADS-B

ADS-B is a system by which aircraft, certain equipped surface vehicles, and fixed ground locations can share (i.e., broadcast) position, velocity, and other information with one another. With such information made available by ADS-B from other proximate aircraft[1], it is possible to establish the relative position and movement of those aircraft with reference to one's own aircraft. It is also possible for ground-based facilities to monitor ADS-B broadcasts to enable basic surveillance capabilities, or to supplement existing surveillance systems. Other data that are shared using ADS-B include information related to the aircraft's intended flight path ("intent" data), aircraft type, and other information.

ADS-B is *automatic* in the sense that no pilot or controller action is required for the information to be broadcast. It is *dependent surveillance* in the sense that the aircraft surveillance-type information is derived from on-board navigation equipment.

ADS-B is considered to be a key enabling technology to enhance safety and efficiency in airspace operations. RTCA Special Committee SC-186 has documented a wide range of applications of ADS-B focused on those goals in RTCA/DO-242A. These include basic applications, such as the use of ADS-B to enhance the pilot's visual acquisition of other nearby aircraft, as well as more advanced applications, such as enabling enhanced closely spaced parallel approach operations. Other applications involving airport surface operations, improved surveillance in non-radar airspace, and advanced conflict management are also described.

### 1.1.2 TIS-B

Traffic Information Service - Broadcast (TIS-B) is a ground-based service to ADS-B-equipped aircraft to provide surveillance data on non-ADS-B-equipped aircraft. TIS-B may also be used in ADS-B implementations involving multiple ADS-B data links to provide a cross-link—or "gateway"—between ADS-B equipped aircraft using different data links. The service is intended to provide ADS-B-equipped aircraft with a more-complete traffic picture in situations where not all aircraft are equipped with ADS-B (or with the same ADS-B data link).

[1] ADS-B can also be used for surveillance of ground vehicles on the airport surface. Use of the term "aircraft" includes ground vehicles equipped with ADS-B.

As commonly envisioned, TIS-B involves three major functions. First, another source of surveillance information on non-ADS-B aircraft (such as Secondary Surveillance Radar (SSR)) must be available. Second, this surveillance information must be converted and processed so as to be usable by ADS-B-equipped aircraft. And third, a broadcast facility and protocol is necessary to convey this information to ADS-B-equipped aircraft.

### 1.1.3 FIS-B

FIS-B is the ground-to-air broadcast of non-control, advisory information needed by pilots to operate more safely and efficiently in the National Airspace System and in international airspace. FIS provides to pilots the necessary weather graphics (e.g., NEXRAD reflectivity) and text (e.g., METAR and TAF), Special Use Airspace information, Notices to Airmen, and other information.

## 1.2 Basic Data Link Functions of the GBT

The GBT's primary function is that of translating data link traffic between the GBT's Air Interface (the RF medium) and the GBT's Ground Interface (interface to other ground systems). The GBT is an event driven system that performs the following three fundamental tasks:

- Reception of ADS-B messages received over the GBT's Air Interface is mapped into ADS-B reports for transmission over the GBT's Ground Interface to an end system.
- Reception of TIS-B reports over the GBT's Ground Interface are mapped into TIS-B messages for transmission over the GBT's Air Interface to aircraft.
- Reception of Uplink Data Blocks containing FIS information over the GBT's Ground Interface are mapped into Ground Uplink messages for transmission over the GBT's Air Interface to aircraft.

Figure 1-1 is a simplified diagram of the GBT relative to other elements.

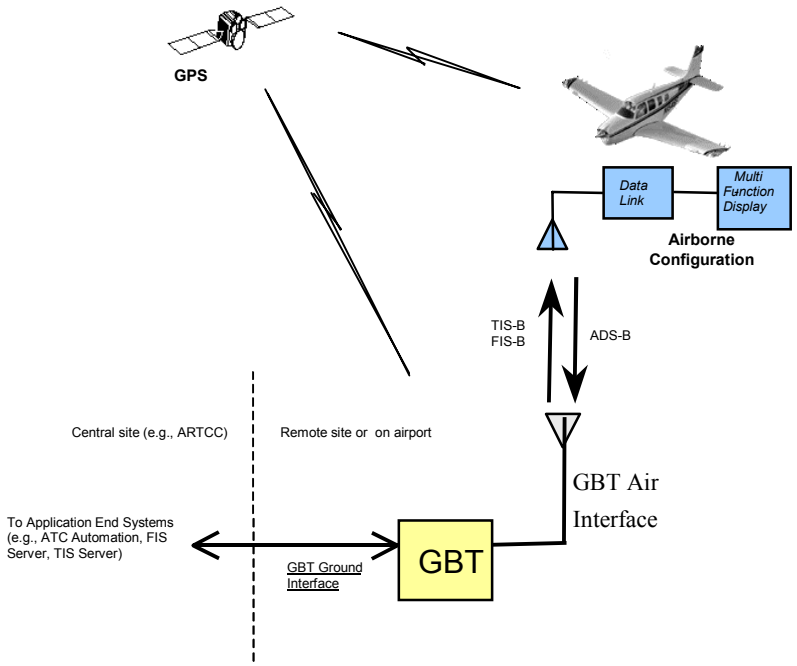



**Figure 1-1 The GBT in Context of Other Elements**

## 1.3 GBT External Interfaces

A simplified diagram of the GBT is shown in Figure 1-2 with each of the system's external interfaces.

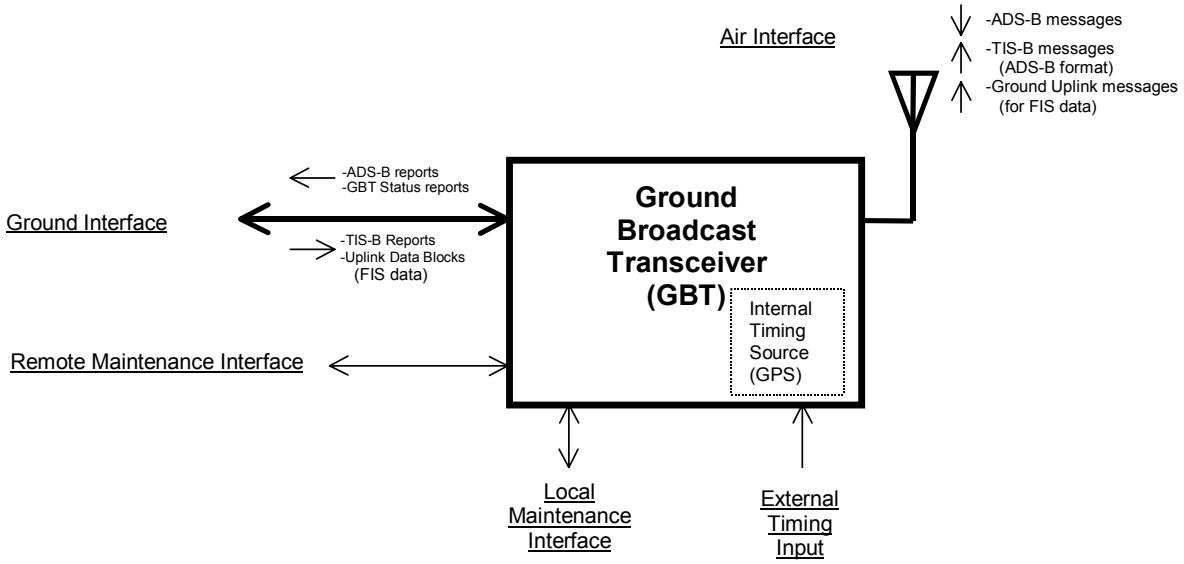



**Figure 1-2. GBT External Interfaces**

### 1.3.1 Air Interface

The GBT Air Interface carries *message* traffic over the data link RF medium. Message traffic includes ADS-B messages transmitted from aircraft, TIS-B messages transmitted from the GBT and Ground Uplink messages transmitted from the GBT.

### 1.3.2 Ground Interface

The GBT Ground Interface conveys ADS-B *reports* from the GBT, TIS-B reports to the GBT and Uplink Data Blocks (containing FIS data) to the GBT. The Ground Interface also conveys periodic Status reports from the GBT.

### 1.3.3 Local Maintenance Interface

The GBT's Local Maintenance Interface supports both monitoring and control of various GBT functions when the technician has physical access to the GBT equipment.

### 1.3.4 Remote Maintenance Interface

The GBT's Remote Maintenance Interface supports most of the monitoring and control functions offered by the local maintenance port. However this interface is intended to be accessed from a central site remote from the GBT equipment.

### 1.3.5 External Timing Input

The GBT requires timing information both to control media access for uplink transmissions and to support time stamping of ADS-B reports. The GBT is specified to have a GPS-based integral time reference. For cases where the GBT is in an environment where the integral GPS time reference cannot be used, an external time source can be applied to the External Timing Input. Selection of integral vs. external timing is configurable.

## 1.4 Data Link Medium for the Air Interface

The GBT governed by this specification employs the Universal Access Transceiver (UAT) data link as the RF medium. It could be more precisely called the "$GBT_{UAT}$". GBT functionality employing the 1090 MHz Extended Squitter data link (the "$GBT_{1090}$") will be specified separately. It is expected that a GBT system employing the 1090 MHz Extended Squitter data link will have external interfaces compatible with those defined by this specification as much as possible—with the exception of the Air Interface. Responses to this specification and the GBT SOW *should* include a description of the 1090 MHz Extended Squitter data link integration into the GBT subsystem. Hereafter in this document the term "GBT" will be used to mean "$GBT_{UAT}$".

## 1.5 Overview of UAT Data Link

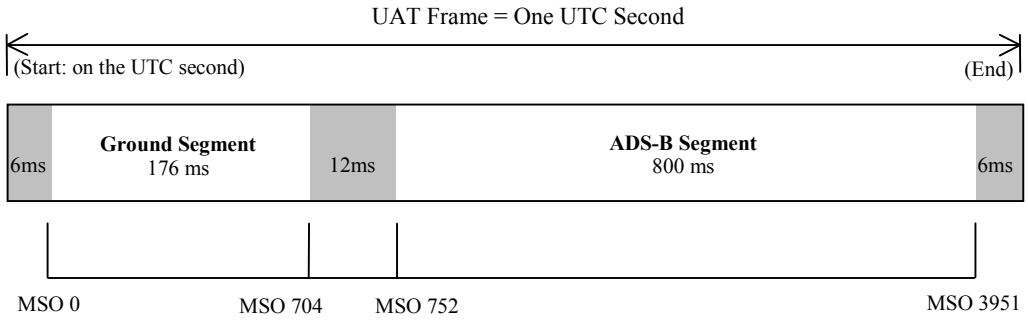
The UAT is a multi-purpose data link intended to operate globally on a single channel with a channel-signaling rate of just over 1Mbps. By design, UAT supports multiple broadcast services including FIS-B and TIS-B in addition to ADS-B. This is accomplished using a hybrid medium access approach that incorporates both time-slotted and random unslotted access. By virtue of its waveform, signaling rate, precise time reference, and message-starting discipline, UAT can also support independent measurement of range to most other participants in the medium.

There are two basic types of broadcast transmissions - or *messages* - on the UAT channel: the ADS-B message, and the Ground Uplink message. An aircraft broadcasts the ADS-B message. TIS-B information will be broadcast by the GBT but using the ADS-B message format. The Ground Uplink message is used by ground stations to uplink FIS data such as text and graphical weather data, advisories, and other aeronautical information, to any aircraft that may be in the service volume of the ground station. Regardless of type, each message has two fundamental components: the message *payload* that contains user information, and message overhead, principally consisting of forward error correction code parity, that supports the transfer of the data.

### 1.5.1 Medium Access Approach

UAT Message transmissions are governed by a combination of time-slotted and random-access techniques. Figure 1-3 illustrates the basic UAT Message timing structure called a UAT *frame*. A frame is one second long and begins at the start of each Universal Coordinated Time (UTC) second. Each frame is divided into two segments: the Ground Segment in which Ground Uplink messages are broadcast[2] in one or more Time Slots, and the ADS-B Segment in which ADS-B messages are broadcast by aircraft and, TIS-B messages from ground stations. Guard times are incorporated between the segments to allow for signal propagation and timing drift. The UAT frame is further divided into Message Start Opportunities (MSOs) that are spaced at 250μs intervals. This spacing represents the smallest time increment used by UAT for scheduling message transmissions, and all such transmissions must start only at a valid MSO.

[2] Ground Uplink messages are used by the GBT for transmitting FIS data, but need not be restricted to only FIS data in the future. However, throughout this specification, the Ground Uplink message is associated with FIS data.




Message Start Opportunities (MSOs)

*Notes*

1. *Shaded segments represent guard times for signal timing drift (not to scale)*
2. *ADS-B transmissions will partially occur within the final guard interval when the last MSO is selected.*

**Figure 1-3. UAT Frame**

As shown in Figure 1-3, 176 milliseconds in each 1-second UAT frame are devoted to Ground Uplink message transmissions and 800ms are devoted to ADS-B message transmissions. MSOs start at the end of the initial 6ms guard time, are spaced at 250μs intervals, and are numbered sequentially from 0 through 3951.

### 1.5.2 ADS-B Message Transmission

As shown in Figure 1-3, the ADS-B Segment of each UAT frame is 800 milliseconds long, and spans 3200 MSOs (i.e., from MSO 752 to, and including, MSO 3951). All aircraft-transmitted ADS-B messages (as well as ground-transmitted TIS-B messages) are transmitted in this segment of the frame. Each UAT-equipped aircraft makes exactly one ADS-B message transmission per frame, and makes a pseudo-random selection from among any of the 3200 MSOs in the segment to start transmission of the message. Six milliseconds of guard time are appended after the ADS-B Segment to fill out the UAT frame to the end of the UTC second.

The pseudo-random selection of an MSO within each UAT frame for the start of an aircraft's ADS-B message is intended to prevent two aircraft from systematically interfering with each other's ADS-B message transmissions. Adherence to the MSO-based timing scheme enables the receiving UAT equipment to determine range to the UAT equipment that transmitted the message. This information could be used in validity checks of the position data conveyed in the ADS-B message itself.

### 1.5.3 TIS-B Transmission

From the perspective of a receiving aircraft, TIS-B transmissions will appear to be nearly identical to ADS-B messages both in terms of message format and media access. For clarity, the term "TIS-B message" will be used throughout this document, even though the ADS-B message format is used for TIS-B. Per this specification, TIS-B messages will also be transmitted in the ADS-B segment of the UAT frame[3]. Detailed procedures for GBT transmission of TIS-B messages are provided in Section 3.2.1.5.

### 1.5.4 Ground Uplink Message Transmission (FIS-B)

Ground Uplink messages are used to support FIS-B. Ground Uplink messages will occur within one or more of the 32 Time Slots defined within the ground segment of the UAT frame. Detailed procedures for Ground Uplink message transmission are provided in Section 3.2.1.6.

## 2.0 Applicable Documents

### 2.1 Government Documents

The following documents form a part of this specification and are applicable to the extent specified here. In case of conflict between the documents referenced here and the contents of this specification, the contents of this specification **shall** take precedence.

### 2.1.1 Orders

| | |
|---|---|
| FAA Order 6950.19A | Practices and Procedures for Lightning Protection, Grounding, Bonding, and Shielding Implementation, July 1, 1996 |

### 2.1.2 Specifications

| | |
|---|---|
| **FAA:** | |
| | |
| FAA-STD-060 | Data Standard for the National Airspace System (NAS), October 4, 2002 |
| | |
| FAA-C-1217F | Electrical Work, Interior, February 12, 1996 |
| | |
| FAA-G-2100G | Electronic Equipment, General Requirements, Latest Version |

[3]Other approaches to uplinking TIS-B are possible using a special TIS-B format and the Ground Segment of the UAT frame. However, this is outside the scope of this specification. Also, there may be additional TIS-B information to be broadcast to describe the service available. The implementation requirements for this additional information are presently undefined. It is expected that this additional information could be conveyed in the Ground Uplink Message.

### 2.1.3 Standards

| **FAA:** | |
|---|---|
| | |
| FAA-STD-019C | Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities, June 1, 1999 |
| | |
| FAA-STD-020B | Grounding, Bonding and Shielding, May 11, 1992 |
| | |
| FAA-E-2911 | NAS System Level Specification, March 26, 1998 |
| | |
| FAA-STD-060, Rev. A | Data Standard for the National Airspace System, (NAS) October 4, 2002 |
| | |
| FAA-STD-026A | Software Development for the National Airspace System (NAS), August 4, 1993 |
| | |
| ICD-GPS-060 | GPS User Equipment (Phase III) Interface |

| **Military:** | |
|---|---|
| | |
| MIL-HDBK-454 (A) | General Guidelines for Electronic Equipment, November 3, 2000 |
| | |
| MIL-STD-461E | Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference, August 20, 1999 |
| | |
| MIL-STD-810F | Environmental Test Methods and Engineering Guidelines, January 1, 2000 |
| | |
| MIL-STD-889B | Dissimilar Metals, May 17, 1993 |

### 2.1.4 Other Government Documents

| **FAA:** | |
|---|---|
| | |
| DOT/FAA/CT-96/1 | Human Factors Design Guide for Acquisition of Commercial Off-the-Shelf Subsystems, Non-Developmental Items, and Developmental Systems, January 15, 1996 |
| DOT/FAA/NAS-IC-51070000-2 | NAS Infrastructure Management System Manager/Managed Subsystem Agent Using the Simple Network Management Protocol Version 3 (SNMPv3) |
| Overview of the FAA ADS-B Link Decision | Presents an overview of the FAA decision on the ADS-B link architecture for use in the National Airspace System and discusses associated operational implications. http://www.faa.gov/asd |

| | |
|---|---|
| **FCC:** | |
| | |
| 47 CFR Part 2 | Frequency Allocations and Radio Treaty Matters; General Rules and Regulations, October 1998 |
| | |
| 47 CFR Part 87 | Aviation Services, October 1998 |
| | |
| **NIST:** | |
| | |
| FIPS PUB 140-1 | Federal Information Processing Standards Publication, Security Requirements for Cryptographic Modules, National Institute of Standards and Technology, January 11, 1994 |
| | |
| FIPS PUB 186-2 | Federal Information Processing Standards Publication, Specifications for Digital Signature Standard (DSS), National Institute of Standards and Technology, January 27, 2000 |
| | |
| **NTIA:** | |
| | |
| | Manual of Regulations and Procedures for Federal Radio Frequency Management, January 2000 Edition with January/May/September 2001 Revisions |

## 2.2 Non-Government Documents

| | |
|---|---|
| **IEEE:** | |
| | |
| IEEE 100-1996 | Standard Dictionary of Electrical and Electronic Terms |
| | |
| IEEE 12207.0 | Software Life Cycle Processes, 1996 |
| | |
| IEEE 12207.1 | Software Life Cycle Processes – Life Cycle Data, 1997 |
| | |
| IEEE 12207.2 | Software Life Cycle Processes – Implementation Considerations, 1997 |
| | |
| **RTCA:** | |
| | |
| DO-282 | Minimum Operational Performance Standards for Universal Access Transceiver (UAT), August, 2002 |
| DO-260A | Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) |

| | |
|---|---|
| **EIA:** | |
| | |
| EIA-310-E | Cabinets, Racks, Panels, and Associated Equipment, March 17, 1999 |
| EIA-232-E | Interface Between Data Terminal Equipment and Data Communications Equipment Employing Serial Binary Data Interchange, 1991 |
| | |
| EIA-422-B | Electrical Characteristics of Balanced Digital Interface Circuits, 1994 |
| | |
| EIA-350 | High Speed 25-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment, 1987 |
| | |
| **IEEE/ANSI:** | |
| | |
| C62.31-1987 | IEEE Standard Test Specifications for Gas-Tube Surge Protective Devices |
| | |
| C62.36-1994 | IEEE Standard Test Method for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits |
| | |
| C62.41-1991 | IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits |
| | |
| C62.47-1992 | IEEE Guide on Electrostatic Discharge (ESD): Characterization of the ESD Environment |
| | |
| Std 519-1992 | IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems |

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|---|---|
| | |
| **IETF:** | |
| RFC 1157 | A Simple Network Management Protocol (SNMP), May 1990 |
| RFC 1901 | Introduction to Community-based SNMPv2, Jan 1996 |

| | |
|---|---|
| **ISO/IEC:** | |
| | |
| ISO/IEC 7498 | Information Technology-Open Systems Interconnection-Basic Reference Model, November 1994 |
| **NFPA:** | |
| | |
| NFPA-70 | National Electric Code |
| | |
| NFPA-780 | Lightning Protection Code |

## 2.3 Documentation Sources

### 2.3.1 FAA Documents

Copies of FAA specifications, standards, and publications may be obtained from Leslie Boehler, Capstone Contracting Officer, FAA, 222 West 7th Avenue, Anchorage AK 99501, telephone (907) 271-5842. Requests should clearly identify the desired material by number and state the intended use of the material. Revision FAA=G-2100G may be downloaded from the FAA at web site http://www.faa.gov/asd/standards/index.htm.

### 2.3.2 Military and Federal Documents

Single copies of unclassified military and federal specifications, standards, and publications may be obtained by writing the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120 or by calling (215) 697 3321 Monday through Friday, 8:00 a.m. to 4:30 p.m. (EST).

### 2.3.3 Federal Communications Commission Documents

Copies of 47 CFR, Part 2 and Part 87 may be obtained from the FCC, 445 12th Street, SW, Washington D.C. or by downloading from the FCC web site at www.fcc.gov/oet/info/rules.

### 2.3.4 Electronic Industries Alliance Documents

Copies of Electronic Industries Alliance (EIA) standards may be obtained from the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201-3834, by calling (703) 907-7500, or through the web site http://www.eia.org.

### 2.3.5 National Telecommunications and Information Administration Documents

Copies of National Telecommunications and Information Administration (NTIA) materials may be obtained from NTIA, Department of Commerce, 14th Street and Constitution Avenue NW, Washington, DC 20230, by calling (202) 377-1832, or through the web site http://www.ntia.doc.gov.

### 2.3.6 RTCA, Inc. Documents

Copies of RTCA, Inc. documents may be obtained from RTCA, Incorporated, 1828 L Street NW, Suite 805, Washington, DC 20036, by calling (202) 833-9339, or through the web site http://www.rtca.org.

### 2.3.7 ISO/IEC Documents

Copies of International Standards Organization documents may be obtained from American National Standards Institute, 11 West 42nd Street, 13th floor, New York, NY 10036. Telephone: (212) 642-4900, Telefax: (212) 398-0023, E-mail: info@ansi.org, Web: http://www.ansi.org/ or http://www.iso.ch/.

### 2.3.8 IEEE/ANSI Documents

Copies of IEEE/ANSI documents may be obtained from IEEE Customer Service, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, or by calling (800) 701-4333 (in U.S. and Canada), or (732) 981-0060 (outside of U.S. and Canada).

### 2.3.9 NIST Documents

Copies of National Institute of Standards and Technology may be obtained from NIST, 100 Bureau Drive, Gaithersburg, MD 20899-3460, or by calling (301) 975-6478.

### 2.3.10 NFPA Documents

Copies of National Fire Protection Association (NFPA) documents may be obtained from NFPA, 1 Batterymark Park, Quincy, MA 02269-9101 or by calling (617) 770-3000.

## 3.0 REQUIREMENTS

### 3.1 Definitions

### 3.1.1 "Shall"

When used in this specification, the word "**shall**" refers to an explicit requirement of a system component or the complete system

### 3.1.2 "***Should***"

When used in this specification, the word "*should*" refers to a desired characteristic of a system component or the complete system.

### 3.1.3 "Will"

When used in this specification, the word "will" provides information for a characteristic of a system component or a complete related system.

## 3.2 GBT Requirements

### 3.2.1 GBT Functions and Software Requirements

Figure 3-1 gives a conceptual overview of the partitioning of the functions of the GBT specified in the subsections below.

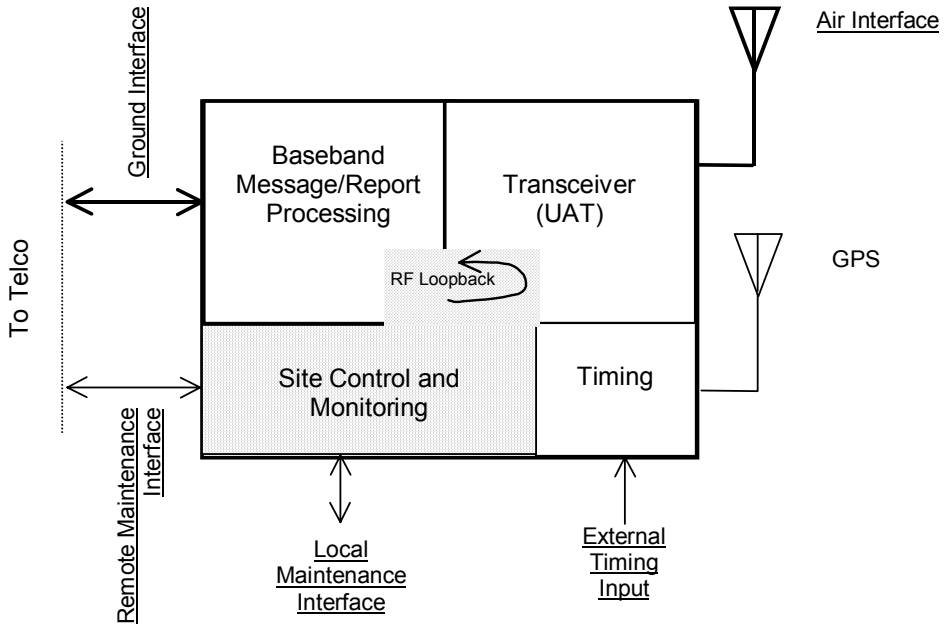



**Figure 3-1. Conceptual Overview of the GBT**

#### 3.2.1.1 System Software

The term "software" as used in this specification **shall** apply to all deliverable items having one or more of the following characteristics:

a. Computational and control logic represented in a higher order language form and defined as source code to be interpreted, assembled, or compiled into machine executable form.

b. Executable program instructions at the micro-code or direct machine executable levels.

c. All data representations required by executable program logic.

d. All data descriptions, state machines, high level Boolean equations, truth tables and logic schematics that reflects the design concept of programmable logic devices (e.g. Programmable Array Logic, Programmable Logic Array, Programmable Logic Sequencer, Programmable Gate Array)

These deliverable items are further identified as being processed/executed on computational /control hardware. This hardware consists of CPU's or programmable controllers/devices or both, whether used as general purpose (as in the computer subsystem) or dedicated hardware.

All items meeting the above criteria **shall** be subject to the software requirements of this specification. The Contracting Officer shall make exceptions only upon written authorization.

The term "firmware" as used in this specification **shall** apply to all computer programs or micro-programs that are loaded in class of memory (Read Only Memory (ROM), Programmable Read Only Memory (PROM), or write able control store) that cannot be dynamically modified by the computer during processing.

#### 3.2.1.1.1 Identification of Software

The GBT software (including firmware) **shall** be divided and identified by two classifications and four categories.

##### 3.2.1.1.1.1 Classes of Software

The two major classifications are NAS Operational Software (NAS OP/SW) and Support Software SW.

a. NAS/OP. All operational software used in the performance of the surveillance mission is classified as real-time, high-reliability, and mission-critical. It consists of the embedded software and firmware, including Built-in-Test and Fault Isolation Test software used by the GBT system. Modifications made to this class of software **shall** conform to the requirements defined in IEEE 12207.

b. Support SW. Support SW is all software used to support development and maintenance of the NAS OP/SW at the Program Support Facility. (PSF) Strong use of COTS software tools will be applied in the production of the NAS OP/SW.

##### 3.2.1.1.1.2 Categories of Software

If applicable, the above two classifications **shall** be divided into each of the following four categories.

a. Reusable Software. This software is developed for the core GBT system and reusable with no modification.

b. Developmental. Computer software configuration items (CSCIs) developed to support the NAS interfaces or other GBT requirements after contract award, or software that requires the revision of more than 30 percent change measured in source lines of code per component.

c. Modified. Software requiring less than 30 percent change measures in source lines of code per component.

d. Commercial-Off-the-Shelf (COTS). This software is purchased from commercial vendors. They may be components of the NAS OP/SW or Support SW.

#### 3.2.1.1.2 Software Partitioning

The GBT operational software components **shall** be clearly identifiable by category. All operational software **shall** be functionally partitioned into, and documented as separate computer software items. Operational software consists of the prime mission equipment software, including the operating system and the software that provides surveillance data, resides in built-in-test equipment, collects and extracts data for analysis, and supports the NAS interfaces.

#### 3.2.1.1.3 Software Standards

a. Software developed prior to contract award **shall** be shown to be developed in accordance with the contractor's documented specifications and standards.

b. All new software and firmware **shall** be developed in accordance with IEEE 12207. When revisions of more than 30 percent of an existing CSCI are made, the entire CSCI **shall** be revised in accordance with IEEE 12207. Design emphasis **shall** be placed on reliability, error detection and reporting, fault tolerance, and recovery from abnormal conditions, as well as functional performance. Modifications to existing code **shall** be developed utilizing the contractor's documented specifications and standards.

#### 3.2.1.1.4 New Software Maintainability

New GBT software **shall** have the following maintainability characteristics:

a. Software performance monitoring and software maintenance operations **shall** not interrupt normal system operation.

b. GBT software **shall** be designed as a collection of software units.

c. Each software unit **shall** include error detection and exception handling capabilities.

d. Each unit **shall** be independently maintainable.

e. Identical software, adapted to the local resources, environment, and workload, **shall** be installed in each site. Local "patches" to executable code and data tables **shall** not be used.

f. New software and firmware developed **shall** support system and subsystem modification, enhancement, and expansion throughout the expected lifetime of the GBT. Provision **shall** be made in instruction code, data tables, and databases, to accommodate additional functions, new equipment, and new data.

g. The software design **shall** provide logical and physical data independence. Changes made to the logical structure of the data **shall** not impact the application programs. Changes made to the physical structure of the data **shall** not impact the logical structure of the data or the application programs. Each level **shall** be complete and independent, containing definitions of data and the operations on the data.

h. The software design **shall** provide data integrity. It **shall** protect data from accidental loss or damage.

i. The software design **shall** provide a controlled approach to adding new data and to modifying and retrieving existing data. It **shall** provide logical data to the application programs as required. It **shall** provide status information to the application programs on the outcome of data requests, including error indications.

j. The software design **shall** assure that the system is initialized to a correct, well-defined state upon recovery from a fault, and that all processing interrupted by a fault is properly continued after recovery.

k. The software design **shall** incorporate a responsive real-time operating system with a standard compiler, loader, software development library (SDL), and other debug and utility tools.

l. Deviations from these requirements that are necessary to meet the overall specifications or are beneficial to the Government **shall** be requested in writing, with contractor justification, and submitted to the Contracting officer. Justifications will include, at a minimum, purpose of deviation, application to the system, delivered product description with documentation, supporting analysis showing that requirements are met, and benefits to the Government.

#### 3.2.1.1.5 Documentation

Documentation of existing or modified software and firmware **shall** consist of requirements, specifications, design documents, and test documents in a format that adheres to the contractor standards. All documentation of new operational and support software **shall** be developed in accordance with IEEE 12207.

### 3.2.1.2 Processor Requirements

a. User access/synchronization schemes in the equipment *should* be configurable.

*Note: The purpose of requesting the access/synchronization schemes to be configurable is to allow ease of changes as data link standards are further refined/defined, and to allow implementation of future capabilities as the GBT system evolves to meet NAS needs.*

b. The GBT **shall** use no more than 50 percent of its non-volatile memory (as defined in Section 5.2.9.1) or storage, under worst-case conditions (e.g., when the GBT has both the software–in-use and a second software version loaded).

c. The GBT **shall** use no more than 50 percent of its Random Access Memory (RAM), under worst-case conditions (e.g., when the GBT has both the software-in-use and a second software version loaded).

d. The processor utilization of the GBT **shall** be 50 percent or less when measured over any 1-second interval when subjected to the maximum loading presented in Section 3.2.2.5 for the Ethernet option of the Ground Interface.

e. If the GBT does not successfully restart after receipt and execution of the Switch Software Version control parameter command, the GBT equipment **shall** revert to the previous version of software and restart.

f. If the software upload is rejected, either by failed Cyclic Redundancy Check (CRC) or incorrect authentication, the GBT **shall** indicate the rejection and the reason for the rejection in the Control Event Log. (Section 3.2.3.5.3)

**3.2.1.3 GBT State and State Transition**

a. The GBT **shall** have the following states: Off, Power Up, Offline, Online, Recovery, Failed and Power Down (if exercised), as defined in Section 5, Figure 5-1, and Table 5-1, as applicable.

b. The GBT **shall** provide visual indication of the Online, Offline, Recovery, and Failed states in accordance with 3.4.1.2.4

*Note: For the definition of critical and non-critical equipment failures see Section 5.2.9.*

**3.2.1.3.1 State Transition**

The GBT **shall** transition from state to state in accordance with Section 5, Figure 5-1, and Table 5-1, as applicable.

**3.2.1.3.2 Off State**

a. When in the OFF state, the GBT **shall** not transmit on the Air Interface.

b. When in the OFF state, the GBT **shall** not generate any form of data output.

c. When DC power is present at the GBT power input, the GBT **shall** provide visual indication of power.

**3.2.1.3.3 Power Up State**

a. When in the Power Up state,

1) The GBT **shall** not transmit on the Air Interface.
2) The GBT **shall** not generate any form of data output.

b. The time between application/restoral of power to the GBT and the GBT's transition out of the Power Up state **shall** not exceed 90 seconds.

c. The GBT **shall** conduct and complete Power On Self Test functions in the Power Up state.

**3.2.1.3.4 Off Line State**

The GBT **shall** be in the Offline state during the period that a Control Session is active as defined in Section 3.2.3.3.1. When in the Offline state the GBT **shall**:

1. Discontinue operational ADS-B message reception and reporting (Section 3.2.1.4).

2. Discontinue operational TIS-B message transmission, if applicable (Section 3.2.1.5).

3. Discontinue operational Ground Uplink message transmission, if applicable (Section 3.2.1.6).

4. Continue Status reporting (Section 3.2.1.7) with an indication the GBT is in the Offline state.

5. Respond to control commands.

*Note: Establishing a Control Session is the only condition that will place the GBT into the Offline state.*

**3.2.1.3.5 On Line State**

When in Online state, the GBT **shall** enable all functions with the exception of those requiring a Control Session.

*Note: Being in the online state does not automatically enable transmission over the Air Interface. The ability to transmit messages over the Air Interface must additionally be enabled through various GBT configuration items.*

**3.2.1.3.6 Recovery State**

a. The GBT **shall** enter the Recovery state when the GBT detects a potentially recoverable failure.

b. Potentially recoverable failures **shall** include, but not be limited to, over temperature conditions.

c. When in Recovery state, the GBT **shall** not transmit.

d. When in Recovery state the GBT **shall** not generate any ADS-B target reports on the Ground Interface.

e. The GBT **shall** transition from the Recovery state to the previous state if the recovery process has been successful (e.g., the recoverable fault was eliminated).

f. The GBT **shall** transition from the Recovery state to the failed state if the recovery process was not successful (e.g., the potentially recoverable fault could not be eliminated).

**3.2.1.3.7 Failed State**

a. When in Failed state,

   1. The GBT **shall** not transmit on the Air Interface.

   2. The GBT **shall** not generate any ADS-B target reports on the Ground Interface.

   3. The GBT **shall** enable only those control parameter commands that can be executed accurately.

b. The GBT **shall** transition to the Failed state if the GBT detects a failure that as a minimum requires the restoral (warm start) action as defined in Section 5.2.7.

#### 3.2.1.3.8 Power Down State

a. If the GBT employs a Power Down state, then when in Power Down state,

   1. The GBT transmitter **shall** not transmit.

   2. The GBT receiver **shall** not generate any form of data output.

   3. All GBT functions **shall** be disabled, except logging/reporting and front panel indication.

b. If the Power Down state is implemented, the GBT **shall** accept the control parameter to transition to the Power Down state ("Power Down" (ID = 16)) only from the Local Maintenance Interface.

### 3.2.1.4 Procedures for ADS-B Message Reception and Reporting

a. The GBT **shall** decode received ADS-B messages per the message format described in Sections 2.2.3 through 2.2.3.1.3.2 of RTCA DO-282.

b. The GBT **shall** convert each such message into an ADS-B report on the GBT Ground Interface in the order received.

#### 3.2.1.4.1 ADS-B Report Construction

a. The GBT **shall** generate ADS-B reports in response to each ADS-B message received.

b. ADS-B reports **shall** be in the format given in the ASTERIX Category 033 description of Appendix A.

c. Individual Data Items of Cat 033 **shall** be determined as given in Table 3-1.

d. The GBT **shall** encode only those data items required for each report and reflect the included data items in the FSPEC (see Appendix A, Section A.2).

*Note: Systems receiving ADS-B reports from the GBT must parse the FSPEC for proper decoding of reports.*

**Table 3-1 Contents of Data Items in the ADS-B Report**

| Source used in Composing Data Item | ASTERIX Cat 33 Data Item | | Criteria for Including Data Item |
|---|---|---|---|
| | FRN[4] | Name | |
| *Data flow →* | | | |
| Fixed field value of ONE | 1 | Version | Every ADS-B report |
| The value of SIC and SAC provided as configuration items | 2 | Data Source Id | Every ADS-B report |
| Bit 3 set; all others ZERO | 3 | Link Indicator | Every ADS-B report |
| Value computed per Section 3.2.1.4.3 | 4 | Time of Applicability | Every ADS-B report |
| Derived from "ADDRESS QUALIFIER" and "ADDRESS" fields of ADS-B message payload. | 5 | Target Address | Every ADS-B report |
| Bit 16 (UTC Coupled): set to ONE if ADS-B message payload indicated "UTC-coupled".<br>Bits 15-4: Derived from "NIC", "SIL" and "NACp" fields of ADS-B message payload.<br>Bit 3 (Position Estimated): Always set to ZERO (for measured position).<br>Bit 2 (Velocity Estimated): Always set to ZERO (for measured velocity) | 6 | Integrity and Accuracy Parameters | Every ADS-B report |
| Derived from "LATITUDE" and "LONGITUDE" fields of ADS-B message payload. | 7 | Latitude/Longitude | Every ADS-B report |
| Derived from the "ALTITUDE TYPE" and "ALTITUDE" fields of the ADS-B message payload | 8 | Pressure Altitude | Every ADS-B report |
| Derived from "A/G STATE", "HORIZONTAL VELOCITY" and "VERTICAL VELOCITY" fields of the ADS-B message | 9 | Velocity (Airborne) | Reported when the "A/G STATE" field of the ADS-B message indicates the AIRBORNE condition. |
| Derived from "A/G STATE", and "HORIZONTAL VELOCITY" fields of the ADS-B message. | 10 | Velocity (Surface) | Reported when the "A/G STATE" field of the ADS-B message indicates the ON GROUND condition. |
| Derived from the Flight Plan ID field of the ADS-B message when "CSID" flag = ZERO | 11 | Mode 3/A Code | Each of these Data Items reported only when present in the ADS-B message. |
| Derived from the "CALL SIGN" field of the ADS-B message | 12 | Target Identification | |
| Derived from the "EMITTER CATEGORY" field of the AD-B message | 13 | Emitter Category | |
| Derived from the "EMERGENCY PRIORITY STATUS" and "OPERATIONAL MODES" field of the ADS-B message. | 14 | Target Status | |
| Derived from the "ALTITUDE TYPE" and "SECONDARY ALTITUDE" fields of the ADS-B message payload | 15 | Geometric Altitude | Reported only when present in the ADS-B message AND reporting of this Item is enabled in the ADS-B_REPORT_FSPEC_FILTER configuration item. |
| N/A | 16 | Reserved | Never |
| Value computed per Section 3.2.1.4.4 | 17 | Time of Message Transmission | Reported only when present in the ADS-B message AND reporting of this Item is enabled in the ADS-B_REPORT_FSPEC_FILTER configuration item. |
| Value computed per Section 3.2.1.4.2 truncated to the fractional seconds | 18 | Time of Message Receipt | Reported when reporting of this item is enabled in the in the ADS-B_REPORT_FSPEC_FILTER configuration item. |
| N/A | 19 | Reserved | Never |
| N/A | 20 | Reserved | Never |
| N/A | 21 | Reserved | Never |

[4] Field Reference Number from the ASTERIX definition (Appendix A)

**3.2.1.4.2 Time of Message Receipt**

a. The GBT **shall** declare a Time of Message Receipt (TOMR) for each ADS-B message received.

b. Time measurement **shall** be relative to the arrival of the optimum sample point of the first bit of the UAT synchronization sequence at the GBT antenna terminal.

*Note: See Sections 2.2.2.3 and 2.2.6.2.2 of DO-282.*

c. Time measurement **shall** be made to a resolution of 100 nanoseconds or less.

*Note: The GBT provides its best estimate of time if in the non-UTC coupled condition with accuracy consistent with requirements of Section 3.2.2.5*

**3.2.1.4.3 Time of Applicability**

The GBT **shall** derive a Time of Applicability for each received ADS-B message based on the TOMR of Section 3.2.1.4.2 above as follows:

a. If the ADS-B message payload indicates "UTC Coupled" and the Non-Precision Condition, the Time of Applicability is the start of the 1-second UTC epoch containing the TOMR.

b. If the ADS-B message payload indicates "UTC Coupled" and the Precision Condition, the Time of Applicability is the start of the 0.2-second UTC epoch containing the TOMR.

c. If the ADS-B message payload indicates "Non-UTC Coupled", the Time of Applicability is the TOMR minus 1 second.

*Note: See Section 2.2.4.5.2.8 of DO-282.*

**3.2.1.4.4 Time of Message Transmission**

a. The GBT **shall** derive a Time of Message Transmission relative to the 1-second UTC epoch based on the "TRANSMIT MSO" field of the ADS-B message payload encoded per Section 2.2.4.5.4.7 of DO-282.

b. The GBT **shall** derive the Time of Transmission unambiguously based on the TOMR from Section 3.2.1.4.2.

*Notes:*

1. *The GBT is required to derive the Time of Message Transmission only for ADS-B messages with the Mode Status element: those with Payload Type Code of "1" or "3" (see DO-282, Section 2.2.4). These are transmitted at a once per 4-second rate.*

2. *This unambiguous derivation is required because only the 6 LSBs are provided in the "TRANSMIT MSO" field of the ADS-B message payload.*

#### 3.2.1.4.5 ADS-B Message Discarding

a. The ADS-B Reporting Interval **shall** be one second and include the entire ADS-B segment of the current UAT frame and the entire Ground Segment of the subsequent UAT frame as depicted in Figure 3-2.

b. The GBT **shall** discard any ADS-B message that cannot be issued as an ADS-B report at the Ground Interface in the ADS-B Reporting Interval within which the corresponding ADS-B message was received.

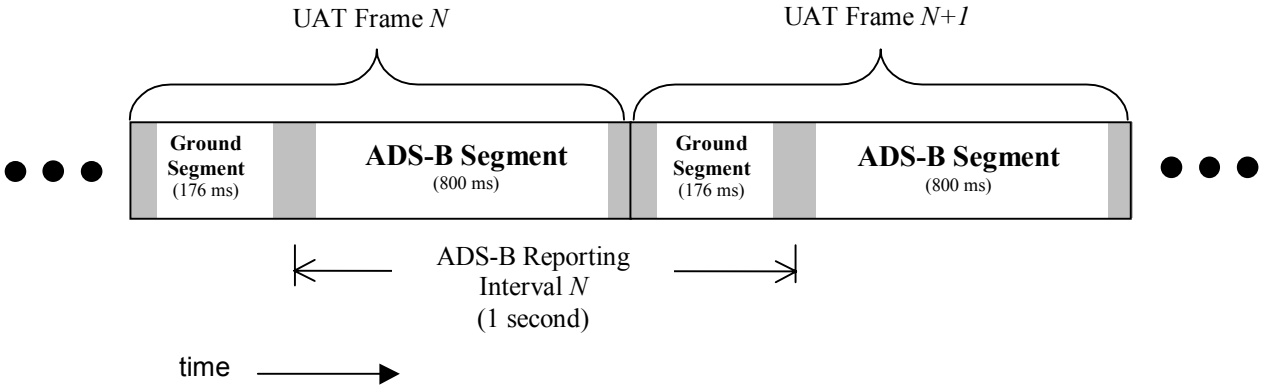



**Figure 3-2. ADS-B Reporting Interval**

*Note: The purpose of the ADS-B Reporting Interval is to establish a systematic method for discarding ADS-B messages when the ADS-B message arrival rate at the Air Interface exceeds the bandwidth available on the Ground Interface. Given the random nature of aircraft ADS-B message transmission within the UAT frame, this discard approach results in a graceful surveillance degradation should the number of ADS-B aircraft momentarily overload the Ground Interface.*

c. When the `TIS-B_FILTER` configuration item is "On", the GBT **shall** discard all received messages whose ADDRESS QUALIFIER field (Section 2.2.4.5.1.2 of DO-282) indicates the message was a TIS-B transmission (i.e., the values "2" and "3").

*Note: Since ADS-B and TIS-B use the same UAT message format; this filter is needed to prevent needless flooding of the Ground Interface due to TIS-B transmissions from co-sited or nearby GBT's.*

#### 3.2.1.4.6 Status Indication

The Status report **shall** provide a count of all ADS-B messages that have been discarded during the current status-reporting interval.

### 3.2.1.5 Procedures for TIS-B Message Transmission

The GBT **shall** receive TIS-B reports over the GBT Ground Side Interface and convert each such report into a TIS-B message on the GBT Air Interface.

**3.2.1.5.1 TIS-B Message Construction**

a. TIS-B messages **shall** use the ADS-B message format described in Sections 2.2.3 through 2.2.3.1.3.2 of RTCA DO-282.

b. The data items present in the corresponding TIS-B report shall determine the payload portion of a TIS-B message. Each data item present **shall** be mapped into its corresponding message payload element per Table 3-2.

c. The GBT **shall** discard all TIS-B reports received prior to the Time of Applicability indicated in the TIS-B report.

d. The GBT **shall** discard all TIS-B reports received more than 2.0 seconds beyond the Time of Applicability indicated in the TIS-B report.

e. The GBT **shall** perform no extrapolation of the position data in the TIS-B report.

**Table 3-2. Payload Composition of TIS-B Message**

| | Source used in Composing Data Item | ADS-B Payload Field Name (RTCA DO-282) | |
|---|---|---|---|
| | | Field Name | DO-282 Ref Para |
| | *Data flow →* | | |
| State Vector Elements present in every TIS-B message | ZERO if all data items in the TIS-B report fit within the "Basic" ADS-B message, otherwise ONE | "PAYLOAD TYPE CODE" | 2.2.4.5.1.1 |
| | The Address Qualifier sub item from the "Target Address" (FRN 5) data item of the TIS-B report | "ADDRESS QUALIFIER" | 2.2.4.5.1.2 |
| | The "24 bit Address" sub item from the "Target Address" (FRN 5) data item of the TIS-B report | "ADDRESS" | 2.2.4.5.1.3 |
| | Derived from the "Aircraft Latitude and Longitude" (FRN 7) data item | "LATITUDE" and "LONGITUDE" | 2.2.4.5.2.1 |
| | Encode as ZERO if the "Pressure Altitude" (FRN 8) data item has information available; otherwise encode as ONE if the "Geometric Altitude" (FRN 15) data item has information available. | "ALTITUDE TYPE" | 2.2.4.5.2.2 |
| | Derive from the "Pressure Altitude" (FRN 8) data item if information available, otherwise derive from the "Geometric Altitude" (FRN 15) data item if information is available | "ALTITUDE" | 2.2.4.5.2.3 |
| | The "NIC" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item. | "NIC" | 2.2.4.5.2.4 |
| | Encode as "2" when "Velocity (Surface)" (FRN10) data item is present; encode as "1" if either N/S or E/W Velocities exceed 1000 kts; encode as "0" otherwise. | "A/G STATE" | 2.2.4.5.2.5 |
| | Derive from information contained in either the "Velocity (Airborne)" (FRN 9) data item or the "Velocity (Surface)" (FRN 10) data item | "HORIZONTAL VELOCITY" | 2.2.4.5.2.6 |
| | Derive from velocity information contained in the "Velocity (Airborne)" (FRN 9) data item. | "VERTICAL VELOCITY" | 2.2.4.5.2.7 |
| | Configuration item `TIS-B_SITE_ID` | "TIS-B SITE ID" | 2.2.4.5.3.1 |
| | | | |
| Mode Status Element present in every TIS-B message generated from a TIS-B report that includes "Target Identification" (FRN 12) | Based on combination of "Emitter Category" (FRN 13) and "Target Identification" (FRN 12) data items encoded in compressed format per Section 2.2.4.5.4.3 of DO-282 | "EMITTER CATEGORY AND CALL SIGN CHARACTERS #1 AND #2" | 2.2.4.5.4.1 and 2.2.4.5.4.2 |
| | | "CALL SIGN CHARACTERS #3, #4 AND #5" | 2.2.4.5.4.2 |
| | | "CALL SIGN CHARACTERS #6, #7 AND #8" | 2.2.4.5.4.2 |
| | Derive from the "Target Status" (FRN 14) data item if available; otherwise encode as "No emergency/Not reported" | "EMERGENCY/PRIORITY STATUS" | 2.2.4.5.4.4 |
| | Encode as "1" | "UAT MOPS VERSION" | 2.2.4.5.4.5 |
| | The "SIL" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item. | "SIL" | 2.2.4.5.4.6 |
| | The 6 LSBs of the MSO selected for this TIS-B message per the procedure in Section 3.2.1.5.2 of this specification | "TRANSMIT MSO" | 2.2.4.5.4.7 |
| | The "NACp" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item. | "NACp" | 2.2.4.5.4.9 |
| | The "NACv" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item. | "NACv" | 2.2.4.5.4.10 |
| | Always encode as ZERO | "$NIC_{baro}$" | 2.2.4.5.4.11 |
| | Always encode as:<br>-CDTI Traffic Display Capability: NO<br>-TCAS/ACAS Installed and Operational: YES | "CAPABILITY CODES" | 2.2.4.5.4.12 |
| | Derive from "Target Status" (FRN 14) data item. | "OPERATIONAL MODES" | 2.2.4.5.4.13 |
| | Always ZERO | "TRUE/MAG" | 2.2.4.5.4.14 |
| | Always ONE | "CSID" | 2.2.4.5.4.15 |
| | Always ALL Zeros | Reserved | 2.2.4.5.4.16 |

#### 3.2.1.5.2 TIS-B Uplink Media Access

a. Each TIS-B message **shall** always begin on an even numbered MSO.

b. TIS-B messages **shall** occur only within the designated TIS-B transmission window(s) described in d) below.

c. When the `TIS-B_OPERATING_MODE` = "Disabled", no TIS-B message transmissions **shall** occur regardless of TIS-B reports received on the GBT Ground Side Interface.

d. When the `TIS-B_OPERATING_MODE` = "Enabled", there **shall** be five TIS-B transmission windows each of 19 milliseconds (76 MSOs) duration. Messages can be either the UAT "Basic" or "Long" format in any combination. The TIS-B transmission windows **shall** occur within the ADS-B Segment of the UAT Frame beginning at each of the following times after the start of the UTC second:

194 milliseconds (MSO 752) + `OFFSET`
354 milliseconds (MSO 1392) + `OFFSET`
514 milliseconds (MSO 2032) + `OFFSET`
674 milliseconds (MSO 2672) + `OFFSET`
834 milliseconds (MSO 3312) + `OFFSET`

Where `OFFSET` is a configuration item that can take on one of the following mutually exclusive values:

**"**ZERO"
"20" milliseconds (80 MSOs)
"40" milliseconds (160 MSOs)
"60" milliseconds (240 MSOs)
"80" milliseconds (320 MSOs)
"100" milliseconds (400 MSOs)
"120" milliseconds (480 MSOs)
"140" milliseconds (560 MSOs)

*Note: A maximum of 38 TIS-B messages can be packed into each transmission window for a maximum capacity of 190 TIS-B messages transmitted per second.*

*Note: TIS-B message transmission times are distributed in this manner to allow TIS-B uplinks to be organized among multiple proximate stations*

e. The GBT receiver shall be available per the requirement of Section 3.2.2.3 at any time during the TIS-B transmission window in which no TIS-B message information is being transmitted.

*Note: During times of light TIS-B report load, there may be a significant portion of the TIS-B transmission window in which no TIS-B message information is transmitted. It is important for ADS-B receptions to be supported when this occurs.*

#### 3.2.1.5.3 Report Discarding

The GBT **shall** discard (i.e., not transmit) any TIS-B report that would incur more than a 600 millisecond TIS-B throughput delay.

#### 3.2.1.5.4 Status Indication

The Status report **shall** provide a count of all TIS-B reports that have been discarded during the current status-reporting interval.

### 3.2.1.6 Procedures for Ground Uplink Message Transmission

*Note: The GBT will receive Uplink Data Blocks in a form that will map directly into the Ground Uplink Application Data field of the Ground Uplink message payload. Therefore each Uplink Data Block received over the GBT Ground Interface will result in a Ground Uplink message. The actual contents of the Ground Uplink Application Data will be transparent to the GBT.*

The GBT **shall** receive Uplink Data Blocks over the GBT Ground Interface and convert each such Uplink Data Block for transmission in a Ground Uplink message.

#### 3.2.1.6.1 Ground Uplink Message Construction

Ground Uplink Messages **shall** use the Ground Uplink message format described in RTCA DO-282 Sections 2.2.3.2 through 2.2.3.2.4 with each field of the message payload determined as described in Table 3-3.

**Table 3-3. Payload Composition of Ground Uplink Message**

| Source used in Composing Data Item | Ground Uplink Payload Field Name (RTCA DO-282) | |
|---|---|---|
| | Field Name | DO-282 Ref Para |
| *Data flow →* | | |
| Configuration item: `GBT_LATITUDE` | "GROUND STATION LATITUDE" | 2.2.3.2.2.1.1 |
| Configuration item: `GBT_LONGITUDE` | "GROUND STATION LONGITUDE" | 2.2.3.2.2.1.2 |
| Configuration item: `POS_VALID` | "POSITION VALID" | 2.2.3.2.2.1.3 |
| Current status of the UTC-coupled 1 PPS signal. | "UTC" | 2.2.3.2.2.1.4 |
| Configuration item: `APP_DATA_VALID` | "APPLICATION DATA VALID" | 2.2.3.2.2.1.6 |
| Time slot (1-32) used for this Ground Uplink message | "SLOT ID" | 2.2.3.2.2.1.7 |
| Configuration item: `TIS-B_SITE_ID` | "TIS-B SITE ID" | 2.2.3.2.2.1.8 |
| All bits set to ZERO | Reserved Bits | 2.2.3.2.2.1.5 and 2.2.3.2.2.1.9 |
| The Uplink Data Block received by the GBT over the Ground Interface mapped bit-for-bit for transmission in the Ground Uplink Application Data in the same order as received | Application Data | 2.2.3.2.2.2 |

#### 3.2.1.6.2 Ground Uplink Message Media Access

The GBT **shall** receive Uplink Data Blocks over the GBT Ground Interface and convert each into a Ground Uplink message on the GBT's Air Interface in the order received.

#### 3.2.1.6.2.1 Time Slots

The GBT **shall** establish 32 Time Slots for transmission of Ground Uplink messages as defined in Table 3-4.

**Table 3-4. Time Slot Definition for the UAT Ground Segment**

| Slot ID # | Time Slot Span | | Slot ID # | Time Slot Span | |
|---|---|---|---|---|---|
| | Starting MSO | Ending MSO | | Starting MSO | Ending MSO |
| **1** | 0 | 22 | **17** | 352 | 374 |
| **2** | 22 | 44 | **18** | 374 | 396 |
| **3** | 44 | 66 | **19** | 396 | 418 |
| **4** | 66 | 88 | **20** | 418 | 440 |
| **5** | 88 | 110 | **21** | 440 | 462 |
| **6** | 110 | 132 | **22** | 462 | 484 |
| **7** | 132 | 154 | **23** | 484 | 506 |
| **8** | 154 | 176 | **24** | 506 | 528 |
| **9** | 176 | 198 | **25** | 528 | 550 |
| **10** | 198 | 220 | **26** | 550 | 572 |
| **11** | 220 | 242 | **27** | 572 | 594 |
| **12** | 242 | 264 | **28** | 594 | 616 |
| **13** | 264 | 286 | **29** | 616 | 638 |
| **14** | 286 | 308 | **30** | 638 | 660 |
| **15** | 308 | 330 | **31** | 660 | 682 |
| **16** | 330 | 352 | **32** | 682 | 704 |

#### 3.2.1.6.2.2 Time Slot Rotation and "Channels"

a. Time Slot resources assignable to the GBT **shall** be made on a continually shifting basis. This assignable resource will be subsequently referred to as a "Channel" to distinguish it from a Time Slot.

b. Channel #1-32 **shall** increment by 1 Time Slot per second (modulo 32).

c. The Channel # and Time Slot # **shall** align at midnight GPS time and every 32 seconds thereafter (see Figure 3-3).

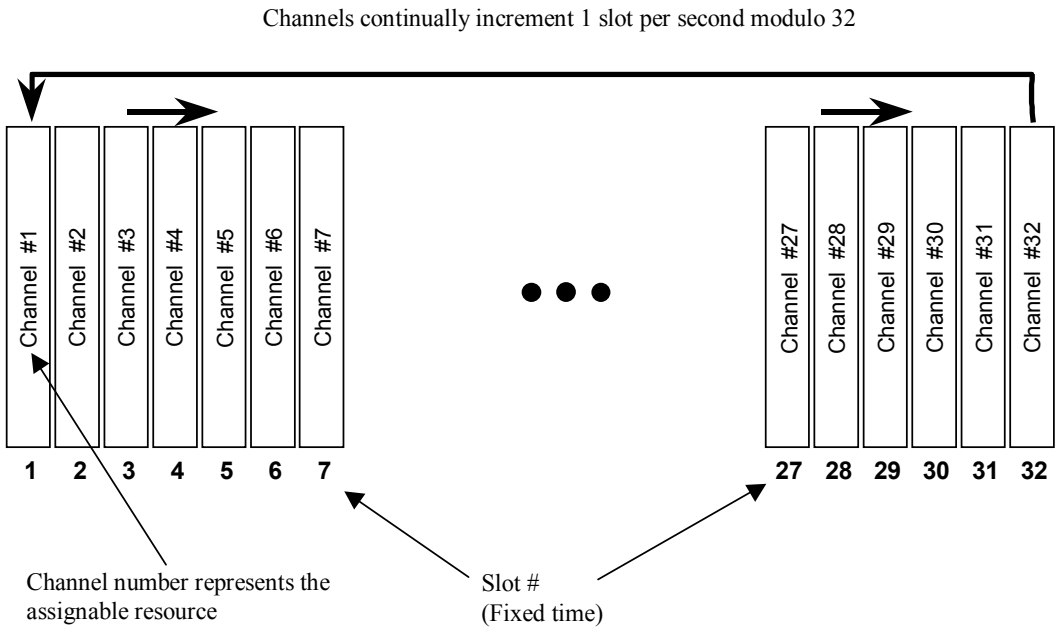



**Figure 3-3. Relationship of "Channels" to Time Slots**

*Note: The reason for the Time Slot rotation is to make aircraft reception of Ground Uplink messages from a given GBT robust in the presence of other time synchronized transmissions in the band (i.e., Link 16).*

#### 3.2.1.6.2.3 Transmission of Ground Uplink Message

a. Ground Uplink message transmissions **shall** occur within the next available Channel specified in the `CHANNEL_LIST` configuration item.

b. Ground Uplink message transmissions **shall** begin at the start of the Time Slot determined by the next available assigned Channel.

*Note: The duration of a Ground Uplink message is approximately 1.5 milliseconds less than the Time Slot duration. This additional time provides a propagation guard time when adjacent Channels (Time Slots) are assigned to GBT ground station sites with common line of sight to the same aircraft.*

#### 3.2.1.6.3 Discarding of Uplink Data Blocks

The GBT **shall** discard any uplink blocks queued for transmission more than 1.2 seconds.

#### 3.2.1.6.4 Status Indication

The Status report **shall** provide a count of all Uplink Data Blocks that have been discarded during the current status-reporting interval.

### 3.2.1.7 Procedures for GBT Status Reporting

#### 3.2.1.7.1 Status Report Construction

a. The GBT **shall** generate Status reports over the Ground Interface on a periodic basis.

b. Status report periodicity **shall** be configurable to one of the following intervals using the `STATUS_REPORT_INTERVAL` configuration item: 1, 2, 3, 4, 5, 6, 10, 15, and 30 seconds.

c. Status reports **shall** be issued within 1 second after the end of the Status Reporting Interval to which it applies.

d. Status reports **shall** be in the format given in the ASTERIX Category 023 description of Appendix B.

e. Individual Data Items of Cat 023 **shall** be determined as given in Table 3-5

**Table 3-5 Contents of Data Items in the Status Report**

| Source used in Composing Data Item | ASTERIX Cat 023 Data Item | | Criteria for Including Data Item |
|---|---|---|---|
| | FRN[5] | Name | |
| *Data flow →* | | | |
| Fixed field value of ONE | 1 | Version Number | Included in every Status report |
| The value of SIC and SAC provided as configuration items | 2 | Data Source Identifier | Included in every Status report |
| The UTC second that marks the end of the Status Reporting Interval. | 3 | Time of Status Report | Included in every Status report |
| Bit 8: GBT Timing status as of the end of the Status reporting interval.<br>Bit 7: Receiver Status as of the end of the Status Reporting Interval.<br>Bit 6: Transmitter status as of the end of the Status Reporting Interval.<br>Bit 5: always ZERO<br>Bits 4-2: GBT State as of the end of the Status Reporting Interval.<br>Bit 1: always ZERO | 4 | GBT Status | Included in every Status report |
| NIC and NACp parameters determined by the GBT's integral GPS sensor at the end of the Status Reporting Interval | 5 | Integral GPS Integrity and Accuracy Parameters | Included in every Status report |
| Position determined by the GBT's integral GPS sensor at the end of the Status Reporting Interval | 6 | Latitude/Longitude | Included in every Status report |
| Count of all ADS-B messages discarded during the Status Reporting Interval | 7 | ADS-B messages discarded | Included in every Status report |
| Count of all TIS-B reports discarded during the Status Reporting Interval | 8 | TIS-B reports discarded | Included in every Status report |
| Count of all Uplink Data Blocks discarded during the Status Reporting Interval | 9 | Uplink Data Blocks discarded | Included in every Status report |

#### 3.2.1.7.2 Status Report Discarding

Status reports **shall** not be discarded or delayed, i.e., they have higher priority than ADS-B reports when the report load exceeds the capacity of the Ground Interface line speed.

[5] Field Reference Number from the ASTERIX definition (Appendix B)

### 3.2.1.8 Characteristics of the Ground Interface

#### 3.2.1.8.1 Interface Decomposition and Options

The GBT Ground Interface **shall** support multiple mutually exclusive interface options with their corresponding protocols as shown in Table 3-6. The protocol employed at each equivalent layer of the OSI model is described in the subparagraphs that follow.

**Table 3-6. GBT Ground Interface Options and Protocols**

| Layer of OSI Model | Interface Option | | | |
|---|---|---|---|---|
| | Ethernet-TCP/IP | Ethernet-UDP/IP | Serial | |
| Application | Application Elements | | | |
| Presentation | Broadcast Services Data Unit (BSDU) | | | |
| Session | Session Layer Data Unit (SDU) | | | |
| Transport | TCP | UDP | Not used | |
| Network | IP | | Not used | |
| Data Link | ANSI/IEEE 802.3 | | ASYNC | SYNC HDLC |
| Physical | EIA/TIA 568A | | EIA-232 | EIA-422 |

#### 3.2.1.8.2 Application Layer: Application Elements

The application layer represents the transfer of the following *application elements*:

- Target Reports (ADS-B or TIS-B)
- Uplink Data Blocks
- GBT Status Reports

##### 3.2.1.8.2.1 Target Reports

The GBT Ground Interface employs a common Target Report format for either TIS-B information to be uplinked by the GBT or ADS-B information that has just been received by the GBT from an aircraft. A single common All Purpose Structured Eurocontrol Surveillance Information Exchange (ASTERIX) encoding structure (Category 033) is used for Target Reports (ADS-B and TIS-B) as given in Appendix A.

##### 3.2.1.8.2.2 Uplink Data Blocks

Uplink Data Blocks are provided to the GBT in a form for direct mapping into the Application Data Field of the UAT Ground Uplink message. The contents and format of the Uplink Data Block is transparent to the GBT.

*Note: Full size Uplink Data Block swill always be provided to the GBT, including fill bits if required.*

##### 3.2.1.8.2.3 GBT Status Reports

GBT Status Reports are issued periodically from the GBT to allow application end systems to monitor GBT health. ASTERIX encoding structure (Category 023) is used for periodic Status reports as given in Appendix B.

### 3.2.1.8.3 Presentation Layer: BSDU

The BSDU serves the following functions:

- Delimit application elements
- Identify application elements
- Provide error detection of the application element that may occur in transmission between the GBT and the ground application end system

a. Each BSDU **shall** encapsulate a single application element.

*Note: This requirement supports a minimum and constant time delay for each ADS-B message.*

b. The format of the BSDU **shall** be as described in reduced font below:

Figure 3-4 below shows the format of the SDU.

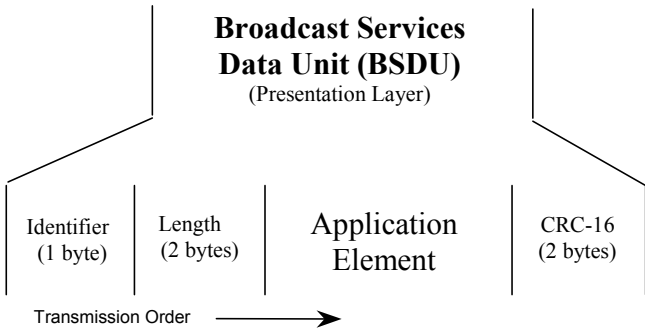



**Figure 3-4. BSDU Construct**

Identifier: This byte is used to distinguish between the different BSDU types indicated in Table 3-7 below. Since Target reports and periodic Status reports use the ASTERIX construction, their BSDU identifier is synonymous with the ASTERIX Category.

**Table 3-7. BSDU ID Byte Values**

| Application Elements | | Value (decimal) | Direction (To/From GBT) |
|---|---|---|---|
| Target Reports | (ADS-B) | 33 | From |
| | (TIS-B) | | To |
| Periodic Status Reports | | 023 | From |
| Uplink Data Blocks (FIS) | | 100 | To |

Length: This is a two-byte field that gives the length in bytes of the BSDU components not including the CRC field (i.e., BSDU ID, BSDU length and Application Element). This definition of length allows compatibility between the BSDU and ASTERIX. "Stuffed" bytes that may be added as part of the procedure described in Section 3.2.1.8.4 are not part of the byte count reflected in this field. This field is encoded as a 16 bit binary integer with the Most Significant byte transmitted first and the Least Significant byte transmitted last.

Application Element: The encoding for each application element is given in the document appendices.

CRC 16: The CRC is inclusive of all fields within the BSDU up to, but not including, the CRC field. Once the CRC-16 value is calculated, it is appended to the end of the BSDU. This field is encoded as a 16 bit binary integer with the Most Significant byte transmitted first and the Least Significant byte transmitted last.

The CRC-16 is a table-driven calculation. The following code generates the 256-entry CRC table:

```
unsigned short int Crc16Table[256];
void InitCrc16 (void)
{
unsigned short int i, bit, crc;
for (i = 0; i < 256; i++)
   {
crc = (i << 8);
for (bit = 0; bit < 8; bit++)
crc = (crc << 1) ^ ((crc & 0x8000) ? 0x1021 : 0);
Crc16Table[i] = crc & 0xFFFF;
   }
```

The following code uses the 256-entry CRC table to calculate the CRC-16. The `crc` variable must be initialized to zero for the first byte and then is set to the previous byte's calculated CRC-16 value for each of the remaining bytes of the message:

```
unsigned short int crc16(unsigned char *buf, unsigned int len)
{
int i;
unsigned short int crc;

crc = 0;
for (i=0; i < len; i++)
crc = Crc16Table[((crc>>8) & 0xFF)] ^ (crc<<8) ^ buf[i];
return (crc);
}
```

### 3.2.1.8.4 Session Layer: SDU

The SDU supports the following functions:

- Distribution of BSDUs to various ground application end systems
- Detection and delimiting of each individual BSDU

a. The GBT **shall** be configurable through the `SDU_WRAPPER` configuration item to either "implement" or "omit" the use of the SDU wrapper.

b. Each SDU **shall** encapsulate exactly one BSDU.

c. The format of the SDU **shall** be as described in reduced font below:

Figure 3-5 shows the format of the SDU.

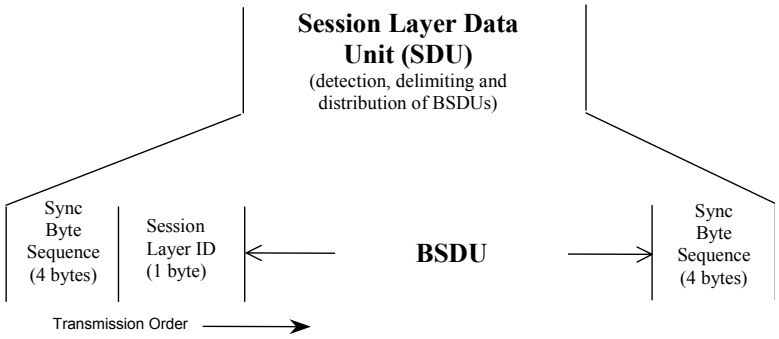



**Figure 3-5. Session Layer Wrapper**

Synchronizing Byte Sequence: synchronizing bytes are used to indicate the start and end of a BSDU in the data stream. The synchronizing byte sequence consists of the following hexadecimal bytes in their transmission order: 01 FF FF FF.

Byte stuffing is performed to eliminate the possibility of a synchronizing byte sequence occurring in an outgoing BSDU. When the first three bytes of the synchronizing byte sequence is found within the outgoing BSDU, one byte with a value of ZERO is inserted (or "stuffed") into the data stream following these three bytes. Byte de-stuffing is performed to remove the occurrence of stuffed bytes in the incoming data stream. When the first three bytes of the synchronizing frame sequence followed by a byte with a value of ZERO is found within the incoming data stream the byte with a value of ZERO is discarded and not used in the construction of a BSDU. The sequence 01 FF FF will only be followed by a 00 or a FF. Any other condition indicates an error in the data.

*Note: When multiple SDUs are transmitted back-to-back, a single synchronizing byte sequence may delimit these messages.*

Session Layer ID: This byte provides an application code for use by a distribution function as part of the ground system external to the GBT. This field is encoded as an 8 bit binary integer with the Most Significant bit transmitted first and the Least Significant bit transmitted last. Table 3-8 shows the encoding of this byte.

**Table 3-8. Session Layer IDs**

| BSDU Type | | BSDU ID (decimal) | SDU ID (hex) |
|---|---|---|---|
| Target Reports | ADS-B | 33 | 0x25 |
| | TIS-B | | 0x22 |
| GBT Status Reports | | 023 | 0x29 |
| Uplink Data Blocks (FIS) | | 100 | 0x20 |

### 3.2.1.8.5 Transport and Network Layers

Two interface types **shall** be available with the Ethernet option: TCP/IP and UDP/IP.

#### 3.2.1.8.5.1 TCP/IP

When the GBT is configured to operate with the TCP/IP option, the GBT **shall** establish a TCP client connection with the GBT host process.

*Note: The external GBT host process acts as a TCP server running at a predefined transport layer port and network layer IP address that is predefined for that application end system (or the distribution function). BSDUs—wrapped in the session layer protocol defined in section 3.2.1.8.4—are sent between the GBT (TCP client) and the GBT host (TCP server) over the established TCP connection*

.

#### 3.2.1.8.5.2 UDP/IP

When the GBT is configured to operate with the UDP/IP option, the GBT **shall** utilize a predefined transport layer port number and the network layer broadcast IP address of the GBT's subnet for each application element type supported. This **shall** take the form of one of the following mutually exclusive configuration options:

a. Each application element is sent on its own unique transport layer port.

b. All application elements are sent on one common transport layer port.

c. All application elements originating from the GBT are sent on a common transport layer port. All application elements destined for the GBT are sent on a common transport layer port, distinct from the port used for data originating from the GBT.

*Note: The GBT need not establish a Transport Layer connection since UDP is a connectionless unacknowledged protocol.*

#### 3.2.1.8.6 Data Link and Physical Layers for Serial Interface

The serial interface **shall** be configurable as Synchronous or Asynchronous when the serial interface option is selected.

#### 3.2.1.8.6.1 Synchronous

The Synchronous interface **shall** operate according to the following:

- HDLC, (unbalanced mode), Asynchronous Receive Mode (ARM) full duplex enabled (assumes a point-to-point communications interface), GBT acts as Primary, sending and receiving only information frames. Supervisory frames and unnumbered format command frames disallowed in either direction. This creates a connectionless/acknowledgeless protocol, i.e. the secondary is always assumed to be logically connected without the need for the primary to perform link-setup or link disconnection.
- Electrical characteristics per EIA-422 interface at 1.2 to 115 kbps with speed selectable as a configuration item.
- Physical characteristics **shall** be in accordance with EIA-530 and Section 3.3.2.1.2

#### 3.2.1.8.6.2 Asynchronous

The Asynchronous interface **shall** operate according to the following:

- Electrical characteristics per EIA-232 at 1.2 to 115 kbps with speed selectable as a configuration item,
- 8 data bits, 1 stop bit, No parity,
- No Flow control.
- Physical characteristics **shall** be in accordance with Section 3.3.2.1.1

#### 3.2.1.8.6.3 Ethernet

The Ethernet interface **shall** be industry standard Ethernet in accordance with ANSI/IEEE 802.3 (ISO/IEC 8802-3).

The physical layer **shall** perform at a minimum of 10 Mbps.

### 3.2.1.9 GBT Timing

a. The GBT **shall** support two sources of timing: an integral GPS-based source and an external source through the External Timing Interface.

b. The source used by the GBT **shall** be determined by the `TIMING_SOURCE` configuration item.

## 3.2.2 Performance Requirements

### 3.2.2.1 Receiver Characteristics

The GBT receiver **shall** meet all the requirements of RTCA DO-282 Sections 2.2.8.2 through 2.2.8.3.4 with exceptions or qualifications as detailed in the subparagraphs below.

***Note:*** *Detailed information exchange formats for transactions on the Local and Remote Maintenance interfaces are to be Vendor defined.*

#### 3.2.2.1.1 Sensitivity for Long ADS-B Messages (supersedes DO-282 Section 2.2.8.2.1.1)

Long ADS-B messages applied to the Air Interface port at a level of –98 dBm **shall** produce a rate of Successful Message Reception of 90% or better under the following simultaneous conditions:

a. The desired signal is subject to the maximum permitted signal frequency offset plus air-to-ground Doppler at 600 knots closure/opening.

b. The desired signal is subject to the maximum modulation distortion allowed in DO-282 Section 2.2.2.4.

***Notes:***

1. *This also ensures that the Basic ADS-B Message will be received at the same desired signal level.*

2. *This **shall** include the effects of the T/R switch.*

#### 3.2.2.1.2 Sensitivity for Ground Uplink Messages (supersedes DO-282 Section 2.2.8.2.1.2)

Ground Uplink messages applied to the Air Interface port at a level of –96 dBm **shall** produce a rate of Successful Message Reception of 90% or better under the following simultaneous conditions:

a. The desired signal is subject to the maximum permitted signal frequency offset.

b. The desired signal is subject to the maximum modulation distortion allowed in Section 2.2.2.4. of DO-282.

*Notes:*

1. *This requirement ensures the baud rate accuracy supporting demodulation in the GBT equipment is adequate to properly receive the longer Ground Uplink message (assuming that the baud rate accuracy of the transmitter is 2 PPM).*

2. *Since reception of the Ground Uplink message results in no output on the Ground Interface, the manufacturer* **shall** *provide the indication of Successful Message Reception in some other way (e.g., test point that provides count of Successful Message Reception).*

3. *This* **shall** *include the effects of the T/R switch.*

**3.2.2.1.3 Receiver Selectivity**

DO-282 Section 2.2.8.2.3 requirements applicable only to equipment classes A0, A1L, A1H, and A2 **shall** apply to the GBT.

**3.2.2.1.4 Receiver Tolerance to Pulsed Interference**

DO-282 Section 2.2.8.2.4 requirements applicable only to equipment classes A0, A1L, A1H, and A2 **shall** apply to the GBT.

**3.2.2.1.5 Receiver Tolerance to Overlapping ADS-B Messages**

DO-282 Section 2.2.8.2.5 requirements applicable only to equipment classes A0, A1L, A1H, and A2 **shall** apply to the GBT.

**3.2.2.1.6 Receiver Desired Signal Dynamic Range**

The GBT **shall** achieve a Successful Message Reception rate of 99% or better when the desired signal level at the Air Interface is between -95 dBm and -10 dBm.

**3.2.2.1.7 Receiver Recovery from Large Inband Signals.**

The GBT **shall** return to the sensitivity specified in Sections 3.2.2.1.1 and 3.2.2.1.2 within 50 microseconds after application of a 4500 microsecond pulse inband at +10 dBm.

*Note: This assures the GBT receiver recovers from a Ground Uplink message transmission from a cosited redundant GBT.*

**3.2.2.2 Transmitter Characteristics**

The GBT transmitter **shall** meet all the requirements of RTCA DO-282 Sections 2.2.2.1 through 2.2.2.7 with exceptions or qualifications as detailed in the subparagraphs below.

**3.2.2.2.1 Modulation Distortion**

DO-282 Section 2.2.2.4 requirements for modulation distortion **shall** also be applicable for Ground Uplink message transmissions from the GBT.

#### 3.2.2.2.2 Transmitter Power Levels and Ranges

a. The GBT **shall** support four power level settings within the ranges as shown in Table 3-9. Power levels are measured in terms of power presented at the Air Interface port of the GBT including the effects of the T/R switch.

**Table 3-9: Transmitter Power Requirements**

| Power Level Setting | Nominal Power | Minimum Power | Maximum Power |
|---|---|---|---|
| "Off" | 0 Watts | | (-80 dBm) |
| "Low" | 10 Watts | 7 watts (+38.5 dBm) | 14 watts (+41.5 dBm) |
| "Medium" | 25 Watts | 16 watts (+42 dBm) | 32 watts (+45 dBm) |
| "High" | 75 Watts | 50 watts (+47 dBm) | 100 watts (+50 dBm) |

b. `POWER_LEVEL` **shall** be selectable as a configuration item.

#### 3.2.2.2.3 Transmitter Power Output

DO-282 Section 2.2.2.5 requirements for the Time/Amplitude profile of transmitted messages **shall** be applicable with the following qualifications:

a. References to Table 2-1 and Table 2-2 in subparagraphs b), c), d) and e) of DO-282 Section 2.2.2.5 **shall** instead refer to Table 3-9 of this specification.

b. Time/Amplitude profile requirements are applicable for all messages transmitted from the GBT.

#### 3.2.2.2.4 Transmitter Timeout

Whenever the RF level at the Air Interface Port exceeds –60 dBm for more than 50% of any 40 millisecond period, the GBT **shall**:

a. Declare a transmitter timeout Alarm in the Status report.

b. Automatically assume the "Off" setting for the Transmitter Level control parameter.

***Note:*** *This requirement is structured for verification testing through intentional "over assignment" of Channels when configuring the GBT (see Section 3.2.2.2.5).*

#### 3.2.2.2.5 Transmitter Duty Cycle

The GBT transmitter **shall** be capable of operating with the simultaneous combination of TIS-B at a full target load of 190 per second and a maximum of 8 Ground Uplink messages per second in any combination of `OFFSET` and `CHANNEL_LIST` assignments.

***Notes:***

*1. A configuration constraint that requires successive Channel assignments to be spaced at most 4 apart is acceptable (e.g., Channel assignments of 1, 5, 9, 13…29 or 2, 6, 10, 14…30 etc).*

2. *However, the GBT **shall** support the configuration of any arbitrary list of channel assignments in order to support verification testing of the "Transmitter Timeout" requirement (Section 3.2.2.2.4).*

### 3.2.2.3 Receiver Availability

The GBT receiver **shall** be enabled and available for message reception except for the intervals that begin a maximum of 50 microseconds prior to the optimum sampling point of the first bit of the synchronization sequence of a transmitted message and ends within the transmit-receive turnaround time.

#### 3.2.2.3.1 Transmit-Receive Turnaround Time

The GBT **shall** switch from transmission to reception and return to the sensitivity specified in Sections 3.2.2.1.1 and 3.2.2.1.2 within 50 microseconds after transmitting a message.

***Note:*** *Transmit to Receive switching time is defined as the time between the optimum sampling point of the last information bit of one transmit message and the optimum sampling point of the first bit of the synchronization sequence of the subsequent receive message.*

### 3.2.2.4 GBT Throughput Performance

GBT throughput performance requirements vary depending on the Ground Interface option selected. The GBT **shall** meet the throughput and delay requirements given in Table 3-10. Each row of the table represents a set of throughput requirements that **shall** be met simultaneously.

**Table 3-10. GBT Throughput Performance Requirements**

| | | ADS-B Messages | | TIS-B Reports | | Uplink Data Blocks (FIS) | |
|---|---|---|---|---|---|---|---|
| | | Req'd Input Load (Note 1) (Messages/sec) | Max Throughput Delay | Req'd Input Load (Note 2) (Reports/sec) | Max Throughput Delay (Note 3) | Req'd Input Load (Note 2) (Blocks/sec) | Max Throughput Delay (Note 4) |
| Ground Interface Option | Ethernet | 500 | All ADS-B messages must be reported within the ADS-B Reporting Interval in which the message was received | 190 | 400 ms | 8 | 1.2 sec |
| | 56 K SYNC | 115 | | 115 | | 0 | |
| | | | | 50 | | 8 | |
| | | | | 0 | | 8 | |
| | 19.2 ASYNC | 31 | | 31 | | 0 | |
| | | | | 15 | | 2 | |
| | | | | 0 | | 4 | |
| | 9.6 ASYNC | 15 | | 15 | | 0 | |
| | | | | 7 | | 1 | |
| | | | | 0 | | 2 | |

*Notes:*

1. *Stimulus will be Long ADS-B messages injected at the Air Interface. ¼ of the ADS-B messages will be presented continuously with no intermessage gap beginning at the start of the ADS-B Segment. The remainder will be random arrivals uniformly distributed across the remaining portion of the ADS-B message Segment of the UAT frame.*

2. *The TIS-B report and Uplink Data Block input load on the Ground Interface are random arrivals uniformly distributed across the entire UAT frame.*

3. *Throughput delay for TIS-B is defined as the time from receipt of the complete TIS-B report over the GBT Ground Interface to the time the TIS-B message transmission over the GBT Air Interface for that target begins.*

4. *Throughput delay for Uplink Data Blocks is defined as the time from receipt of the complete Uplink Data Block over the GBT Ground Interface to the time the Ground Uplink message transmission over the GBT Air Interface for that target begins.*

5. *The three serial interface options each contain three separate test scenarios for uplink data load: All TIS-B with no FIS-B, all FIS-B with no TIS-B and one with a mixture of both. All scenarios include the full load of ADS-B messages.*

#### 3.2.2.5 GBT Timing Source

a. The GBT **shall** employ a GPS-based timing source referenced to UTC that supports a timing accuracy of +/- 500 ns of UTC. When UTC timing is available from the GPS source, the GBT **shall** be in the UTC-coupled condition

b. When the GBT has entered the ALARM condition for the GBT Timing Status monitor parameter, the GBT **shall** estimate—or "coast"—time such that the GBT assigns the "Time of Applicability" data item for ADS-B reports with an error of no greater than +/- 1 second from the actual time of applicability for up to 1 hour.

#### 3.2.2.5.1 GPS Antenna

a. A matching GPS antenna **shall** be provided for the GPS system.

b. The requirement of Section 3.2.2.5.a., **shall** be met with up to 100 meters of GPS antenna cable through the use of a programmable cable delay, if required.

c. The requirements of Section 3.4.3.1.2 **shall** be met.

#### 3.2.2.5.2 GPS Satellite Tracking and Masking

a. The GPS subsystem **shall** be capable of tracking a minimum of eight satellites simultaneously.

b. Accurate timing as defined in Section 3.2.2.5.a **shall** be capable of being generated from only one satellite.

c. Normal satellite masking **shall** apply for any satellites below 10 degrees above the horizon. This angle **shall** be reduced to 0.5 degrees above the horizon if insufficient satellites above 10 degrees above the horizon are available to provide accurate timing.

#### 3.2.2.5.3 GPS Receiver System Sensitivity

The GPS system is designed to provide a –130-dBm signal at the earth surface. To provide a level of immunity from environmental attenuation, the GPS receiver **shall** have the capability to acquire signals of at least –136 dBm level at the antenna and remain tracking to a level of at least –143 dBm signal strength.

### 3.2.3 Site Control and Monitoring

#### 3.2.3.1 Technician Access

The GBT **shall** support access by maintenance technicians for control and monitoring of GBT parameters in one of two ways:

a. A Local Maintenance Interface on the front panel of the GBT for connection of a local PC for test and control functions.

b. A Remote Maintenance Interface on the rear of the GBT for connection to the control facility.

#### 3.2.3.1.1 Local Maintenance Interface

a. The GBT **shall** accept control input, provide control replies, and provide monitoring output and alarm/alert indications via the Local Maintenance Interface connector.

b. The GBT **shall** continue to operate with a local maintenance terminal connected, logged in, and upon removal of the local maintenance terminal.

#### 3.2.3.1.2 Remote Maintenance Interface

a. The GBT Remote Maintenance Interface *should* implement SNMPv1 in accordance with RFC 1157 and SNMPv2c in accordance with RFC 1901 for remote monitor and control in addition to the protocols required by NAS-IC-51070000-2.

b. The GBT **shall** accept control input, provide control replies, and provide monitoring output and alarm/alert indications via the Remote Maintenance Interface connector.

c. The GBT **shall** continue to operate with the Remote Maintenance Interface connected, logged in, and upon removal of the Remote Maintenance Interface.

*Note: The FAA's NIMS management platform is only SNMPv1 and SNMPv2c compatible at this time. An upgrade to SNMPv3 is planned for the future.*

#### 3.2.3.1.3 Management Information Base

The GBT Management Information Base (MIB) *should* be implemented IAW NAS-IC-51070000-2.

### 3.2.3.2 GBT Internal RF Test Support

*Note: The requirements of this section are intended to support monitoring of the GBT's RF performance on a remote basis. Differing support is needed for each of the two following GBT conditions; when in the online state (fully operational), and when placed in the Offline state by the maintenance technician (non-operational).*

#### 3.2.3.2.1 ADS-B Test Message (Online State)

a. The GBT **shall** generate an ADS-B Test message in the "Basic" ADS-B message format to verify operation of the ADS-B reception function.

b. The ADS-B Test message **shall** be composed according to Table 3-11.

**Table 3-11. Payload Composition of ADS-B Test Message**

| ADS-B Message Payload Field | | Contents |
|---|---|---|
| Field Name | DO-282 Ref Para | |
| "PAYLOAD TYPE CODE" | 2.2.4.5.1.1 | ZERO ("Basic" ADS-B message) |
| "ADDRESS QUALIFIER" | 2.2.4.5.1.2 | "5" (Code for "Fixed ADS-B Beacon") |
| "ADDRESS" | 2.2.4.5.1.3 | Configuration item ADS-B_TEST_MSG_ADDR |
| "LATITUDE" and "LONGITUDE" | 2.2.4.5.2.1 | Provided each second by integral GPS |
| "ALTITUDE TYPE" | 2.2.4.5.2.2 | ZERO |
| "ALTITUDE" | 2.2.4.5.2.3 | ALL ZEROS (Code for "Information not available") |
| "NIC" | 2.2.4.5.2.4 | Provided each second by integral GPS |
| "A/G STATE" | 2.2.4.5.2.5 | ALL Zeros |
| "HORIZONTAL VELOCITY" | 2.2.4.5.2.6 | Provided each second by integral GPS |
| "VERTICAL VELOCITY" | 2.2.4.5.2.7 | ALL Zeros |
| "TIS-B SITE ID" | 2.2.4.5.3.1 | ALL Zeros |

c. The ADS-B Test message **shall** be generated once every twelve seconds.

d. The ADS-B Test message **shall** not conflict with any ADS-B message reception during the ADS-B segment of the UAT frame.

e. The ADS-B report resulting from the ADS-B Test message **shall** always be reported in the reporting interval in which it was generated regardless of the ADS-B message load.

f. The ADS-B Test message **shall** be inserted into the receiver front end, to include any receiver power or pre-amplifiers, so that a complete system check can be initiated.

g. The level of the ADS-B Test message present at the receiver front end **shall** be at least 5 dB above the level required to achieve a rate of Successful Message Reception of 90% or better.

h. The level of the ADS-B Test message present at the Air Interface port **shall** not exceed –60 dBm.

#### 3.2.3.2.2 Loopback Test Mode (Offline State)

*Note: The Loopback mode samples and receives the GBT uplink transmissions at the receiver front end so the reception can be reported on the GBT's Ground Interface. Loopback mode also supports a power measurement of Ground Uplink messages. Loopback mode is intended only for maintenance use as a remote check on the transmitter functionality.*

When placed in the Loopback test mode:

a. The GBT **shall** transmit a single TIS-B in response to a loopback message in accordance with the requirements of Section 3.2.1.5. through 3.2.1.5.2. within 2 seconds of receipt of a TIS-B report on the Ground Interface.

*Note: The loopback test for TIS-B messages will be supported though a special loopback application external to the GBT. This loopback application provides a stimulus consisting of a single TIS-B report applied to the GBT's Ground Interface. The loopback application will expect an ADS-B report to be subsequently received from the GBT's Ground Interface for bit-wise comparison with the original TIS-B report.*

b. The GBT **shall** transmit a single Ground Uplink message in response to a loopback message in accordance with the requirements of Sections 3.2.1.6 through 3.2.1.6.2.3 in Channel #32 within 2 seconds of receipt of an Uplink Data Block on the Ground Interface.

*Note: The loopback test for Ground Uplink messages will be supported though a special loopback application external to the GBT. This loopback application provides a stimulus consisting of a single Uplink Data Block applied to the GBT's Ground Interface. The loopback application will expect a "read back" of the Uplink Data Block to be subsequently received from the GBT's Ground Interface for bit-wise comparison. There is no requirement for the GBT to either compose or confirm the information in the loopback message.*

c. The GBT **shall** transmit all messages in loopback mode according to the `POWER_LEVEL` configuration parameter.

*Note: This is necessary to simultaneously support the remote power level measurement. Maintenance procedures and the loopback application will ensure resulting messages are infrequent and formatted such that they will be ignored by avionics equipment.*

d. The GBT *should* provide a power level measurement for each Loopback Ground Uplink message transmitted and report the measured level in the Measured Power Output monitoring parameter (ID # 57).

e. Message receptions in Loopback test mode:

   1. **Shall** be processed through the receiver's RF section, to include the T/R switch when present.

   2. **Shall** result in an ADS-B report on each Successful Message Reception of the TIS-B loopback message.

   3. **Shall** result in an Uplink Data Block (sent from the GBT) on each Successful Message Reception of the Ground Uplink loopback message.

f. The GBT **shall** remain in Loopback test mode until explicitly taken out of Loopback test mode, or until the Control Session is terminated, which ever comes first.

#### 3.2.3.2.3 Sensitivity Test Mode (Offline State)

*Note: The Sensitivity test mode causes ADS-B Test messages to be internally generated and injected into the receiver. This mode allows the maintenance technician to control the level of the ADS-B Test message as applied to the receiver front end. By comparing the ADS-B report rate to the known rate of internal ADS-B Test messages transmitted, the technician is able to estimate the receiver sensitivity. Sensitivity test mode is intended only for maintenance use as a remote check on the receiver.*

When placed in the Sensitivity test mode:

a. The GBT *should* generate ADS-B Test messages in accordance with the requirements of Section 3.2.3.2.1 with the exception that the ADS-B test message is generated at a rate of once per second.

b. The GBT *should* support adjustment of the level of the ADS-B Test message in a range of at least ± 10 dB relative to the sensitivity threshold for Basic ADS-B messages (see Section 3.2.2.1.1) in 1 dB increments.

c. The level of the ADS-B Test message provided to the receiver for each adjustment step *should* be stable and repeatable to within ± 1 dB.

d. A sample of the ADS-B Test message being injected into the receiver *should* be provided at an externally accessible test point.

### 3.2.3.3 GBT Control

#### 3.2.3.3.1 Control Session

*Note: A control session is used to convey control parameters, and receive both control replies and solicited monitoring messages. A control session is not required for unsolicited radio monitoring messages.*

*Note: A user will log in either via the Remote Maintenance Interface or the Local Maintenance Interface to initiate a control session. A session is initiated after receipt of a Login and authentication of a security key. A session ends with a log-out, physical disconnection of the Local Terminal, or when no control parameters are received within 30 minutes.*

a. The GBT **shall** initiate a control session upon successful authentication of log on / security key.

b. As long as a valid session is active on one control interface, the GBT **shall** reject all control parameters from the other control interface.

c. The GBT **shall** terminate the control session upon log-out, disconnection of local maintenance terminal, or after no control parameter is received within 30 minutes.

d. The GBT **shall** be in the Offline State during a control session.

e. A control parameter command shall be processed within an average of 1 second over any 15-minute period with a maximum time of 2 seconds.

#### 3.2.3.3.2 Control Parameter Adjustments

a. The GBT **shall** allow modification of the control parameters of the GBT equipment summarized in Table 3-12.

b. The GBT equipment **shall** set parameters to within the tolerance of the associated monitoring parameter (i.e., same Parameter ID).

*Note: In some cases the step size is finer than the resolution to allow for finer tuning of the parameters using external test equipment.*

*Note: The control parameter value ranges, maximum step sizes and default values are summarized in Table 3-12.*

c. The GBT **shall** reply to request messages with a reply message containing the parameter setting actually enacted by the GBT.

d. Rejected request messages **shall** contain the original parameter setting with an error code indicating the reason for rejection.

## Table 3-12. GBT Control Parameters

| ID | Control Parameter | Arguments (if applicable) | Settings | | | |
|---|---|---|---|---|---|---|
| | | | Min | Max | Step | Initialization Default |
| | **GBT Configuration Items (see Table 3-13 for description):** | | | | | |
| 1.1 | SIC | N/A | Value in the range 0-255 | | | 0 |
| 1.2 | SAC | N/A | Value in the range 0-255 | | | 0 |
| 1.3 | TIS-B_FILTER | N/A | "On"/"Off" | | | "On" |
| 1.4 | TIS-B_OPERATING_MODE | N/A | "Enabled"/"Disabled" | | | "Disabled" |
| 1.5 | OFFSET | N/A | 0 ms | 140 ms | 20 ms | 0 |
| 1.6 | GBT_LATITUDE | N/A | -90° (S) | 90° (N) | 0.001 minutes | 0° |
| 1.7 | GBT_LONGITUDE | N/A | -180° | 180° | 0.001 minutes | 0° |
| 1.8 | POS_VALID | N/A | TRUE/FALSE | | | FALSE |
| 1.9 | APP_DATA_VALID | N/A | TRUE/FALSE | | | TRUE |
| 1.10 | TIS-B_SITE_ID | N/A | Value in the range of "0" to "16" | | | "0" |
| 1.11 | CHANNEL_LIST | N/A | List of up to 8 values in the range of 1- 32 | | | NULL set |
| 1.12 | <Ground Interface Parameters> | See Table 3-14 | | | | |
| 1.13 | (Reserved) | | | | | |
| 1.14 | POWER_LEVEL | N/A | 4 fixed settings (See Table 3-9) | | | "Medium" |
| 1.15 | TIMING_SOURCE | N/A | "Integral"/"External" | | | "Integral" |
| 1.16 | STATUS_REPORT_INTERVAL | N/A | One of the following values: 1, 2, 3, 4, 5, 6, 10, 15, or 30 seconds | | | 6 seconds |
| 1.17 | ADS-B_REPORT_FSPEC_FILTER | N/A | List of FRN #s from Cat 33 that will always be suppressed in ADS-B reports. Possible values are: 15 through 21 | | | NULL set |
| 1.18 | ADS-B_TEST_MSG_ADDR | N/A | 1 | $2^{24}$-1 | 1 | ALL ONES |
| 5 | **Real Time Read Back**: Requests real time monitoring values for the desired monitoring parameter . | -Monitoring Parameter<br>-Interval<br>-# of iterations | N/A | N/A | N/A | N/A |
| 6 | **Event Log Read Back**: Requests the GBT event log entries for the desired monitoring parameter | Filter criteria (Section 3.2.3.5.8) | N/A | N/A | N/A | N/A |
| 7 | **GPS Satellite Observation Log Readback**: Requests the satellite observation log entries specified. | Filter criteria (Section 3.2.3.6) | N/A | N/A | N/A | N/A |
| 10 | **Alarm/Alert Threshold Setting**: The Threshold Setting parameter provides new alert and alarm threshold values for the various monitoring parameters. This parameter includes the parameter ID and the new alert and alarm thresholds. | Monitoring Parameter (See Table 3-15) | Anywhere in range of Monitoring Parameter | | | See Table 3-15 |
| 11 | **Suppress Alert/Alarm**: The Suppress Alert/Alarm parameter is an action signal to command the GBT to cease transmitting alert and alarm messages to the Local and Remote Maintenance Interfaces or resume normal alert and alarming. | Monitoring parameter | Two discrete values:<br>-Suppress,<br>-Normal | | | Normal |
| 15 | **Reset**: This is an action signal that commands the GBT to do a warm boot reset (restart while retaining control parameter settings) or a factory reset (restart after returning all control parameters to initialization default values) | N/A | Two discrete values:<br>-Warm Reset,<br>-Factory Reset | | | N/A |
| 16 | **Power Down (if implemented):** | N/A | N/A | | | N/A |
| 20 | **Software Upload Enable/Disable**: This is an action signal that enables the equipment to upload operational software. | N/A | Two discrete values:<br>-Enable Upload,<br>-Disable Upload | | | Disable Upload |
| 21 | **Software Upload**: This is the mechanism for actually uploading the operational software executable image. This parameter is used in conjunction with parameter 22. | -Block Number,<br>-Total Blocks,<br>-Binary Data Block (variable length) | N/A | N/A | N/A | N/A |
| 22 | **Switch Software Version**: This is an action signal that indicates to the equipment to reboot with the stored software image indicated. | N/A | N/A | N/A | N/A | N/A |
| 25 | **Test Mode**: This places the GBT in the Loopback test mode, the Sensitivity test mode or Test mode OFF to allow remote checks of the transmitter (and receiver remotely. | N/A | Three possible settings:<br>-"Loopback test mode",<br>-"Sensitivity test mode",<br>-"Test mode OFF" | | | Test mode OFF |

| ID | Control Parameter | Arguments (if applicable) | Settings | | | |
|---|---|---|---|---|---|---|
| | | | Min | Max | Step | Initialization Default |
| 26 | **ADS-B Test Message Level**: Allows the maintenance technician to adjust the level in 1 dB steps to ascertain the receiver sensitivity. This control parameter is only available when the Test Mode parameter is set to "Sensitivity test mode" | N/A | A range of at least +/- 10 dB around the sensitivity threshold (90% Successful Message Reception) in 1 dB increments | | | N/A |

*Note*

*The Initialization Default values for each parameter represents the "hard-coded" factory settings required upon GBT initialization.*

### 3.2.3.3.2.1 GBT Configuration Items (ID = 1.1 through 1.15)

The GBT configuration items **shall** perform the functions indicated in Table 3-13 and Table 3-14

**Table 3-13. Description of GBT Configuration Items**

| ID | GBT Configuration Item | Description |
|---|---|---|
| 1.1 | SIC | System Identification Code: used to identify individual systems |
| 1.2 | SAC | System Area Code: used to identify regions of the world |
| 1.3 | TIS-B_FILTER | When set, this flag eliminates reporting of TIS-B messages |
| 1.4 | TIS-B_OPERATING_MODE | When set, this flag enables TIS-B message transmissions when the GBT is in the Online state |
| 1.5 | OFFSET | Controls the offset timing for TIS-B message transmissions for a particular GBT. This value will vary among proximate GBT sites to ensure TIS-B message transmissions will not be subject to "same slot" interference |
| 1.6 | GBT_LATITUDE | Surveyed location provided to the GBT |
| 1.7 | GBT_LONGITUDE | Surveyed location provided to the GBT |
| 1.8 | POS_VALID | Set to indicate to avionics that the Ground Uplink message contains a valid position |
| 1.9 | APP_DATA_VALID | Set to indicate to avionics that the Ground Uplink message contains a valid application data |
| 1.10 | TIS-B_SITE_ID | Allows avionics to link TIS-B messages with physical location of the GBT from which they are transmitted (via the position encoded in the Ground Uplink messages) |
| 1.11 | CHANNEL_LIST | List of Channels available to this GBT as a resource for transmitting Ground Uplink messages |
| 1.12 | <Ground Interface Parameters> | (see Table 3-14) |
| 1.13 | (Reserved) | |
| 1.14 | POWER_LEVEL | Sets the GBTs power level to one of four settings |
| 1.15 | TIMING_SOURCE | Selects either the GBTs integral (GPS) timing source or the external timing source for purposes of controlling media access and time stamping reports |
| 1.16 | STATUS_REPORT_INTERVAL | Selects the periodic reporting interval for the Status report |
| 1.17 | ADS-B_REPORT_FSPEC_FILTER | Determines which optional Data Items from the Cat 33 report definition (Appendix A) are to be included in ADS-B reports |
| 1.18 | ADS-B_TEST_MSG_ADDR | Establishes the "ADDRESS QUALIFIER" and "ADDRESS" fields of the ADS-B test message |
| | | |
| | | |

**Table 3-14. GBT Ground Interface Configuration Items**

| Configuration Item | Possible values | Default | Description |
|---|---|---|---|
| PHYSICAL_INTERFACE_TYPE | "Ethernet" or "Serial" | "Serial" | The groundside interface will be limited to one physical connection, either Ethernet or serial. |
| Ethernet Parameters: | | | Ethernet parameters: The Ethernet parameters are only applicable when the physical interface is set to 'Ethernet'. |
| NETMASK | Class C Address | 255.255.255.0 | The network layer IP subnet mask value. This value, combined with the SOURCE_IP_ADDR defines the address space and range on the subnet. |
| SOURCE_IP_ADDR | Class C Address | 192.168.1.1 | The IP address of the GBT. |
| DESTINATION_IP_ADDR | Class C Address | 192.168.1.255 | The IP address of the network node communicating with the GBT. All data received from the airside interface will be sent to this IP address. This will be the IP address of the TCP server if the TCP transport layer protocol is used. |
| GATEWAY_IP_ADDR | Class C Address | 192.179.1.254 | The IP address of the network node used for communicating with external subnets. |
| TRANSPORT_LAYER_PROTOCOL | "UDP" or "TCP" | "UDP" | The groundside interface will be limited to one logical connection using either the TCP or UDP transport layer protocol. |
| SOURCE_PORT | 0 to 99999 | 22222 | Port number to receive uplink data. |
| DESTINATION_PORT | 0 to 99999 | 33333 | Port number to transmit downlink data. |
| LISTEN_PORT | | | Port number to connect to the TCP server. Both uplink and downlink data will be sent over this port. |
| Serial Parameters: | | | The serial parameters are only applicable when the physical interface is set to 'serial'. The GBT serial interface will be wired as data communications equipment (DCE). |
| BAUD_RATE | 1.2, 2.4, 4.8, 9.6, 19.2, 38.4, or 57.6 Kbps | 19.2 Kbps | All standard serial communications baud rate values are acceptable. Values represent Kilobits per second. |
| DATALINK | "Sync " or "Async" | "Async" | When the asynchronous protocol is selected, the serial interface will be set to 8 data bits, no parity, and one stop bit (8-none-1). When the synchronous protocol is selected, HDLC, NRM mode (unbalanced), ARM enabled (assumes a point-to-point full duplex communications interface), GBT acts as Primary sending only information frames. Supervisory frames and Unnumbered frames disallowed in either direction. |
| SYNC_FRAMES | "On" or "Off" | "On" | Use or omit the message delimiting synchronizing sequence |
| | | | |
| Session Layer Parameters: | | | |
| SDU_HEADER | "On" or "Off" | "On" | Use or omit the session layer header |
| | | | |

#### 3.2.3.3.2.2 Real Time Read Back (ID = 5)

The real time read back parameter **shall**:

a. Cause the GBT equipment to reply with a monitoring message containing the real time monitored value of the monitoring parameter specified.

b. Accept three arguments: monitoring parameter, Interval, and number of iterations.

*Note: This supports the requirement of Section 3.2.3.4.b.1.*

#### 3.2.3.3.2.3 Event Log Read Back (ID = 6)

The event log read back parameter **shall** cause the GBT equipment to reply with the event log entries for the filter criteria specified.

*Note: This supports the requirement of Section 3.2.3.5.7.*

#### 3.2.3.3.2.4 GPS Satellite Observation Log Read back (ID = 7)

The GPS Satellite Observation log read back parameter **shall** cause the GBT equipment to reply with the log entries for the filter criteria specified.

*Note: This supports the requirement of Section 3.2.3.6.*

#### 3.2.3.3.2.5 Alarm/Alert Threshold Setting (ID = 10)

The threshold setting parameter **shall**:

a. Establish new alert and alarm threshold values for the monitoring parameters as specified in Table 3-15, item 55.

*b.* Contain thresholds for low Alarm, high Alarm, low Alert, high Alert (as applicable) of variable type with values anywhere in the range of the associated parameter values specified in Table 3-15.

#### 3.2.3.3.2.6 Suppress Alert/Alarm (ID = 11)

The suppress alert/alarm parameter **shall** cause the GBT equipment to cease or resume transmitting alert and alarm messages to the Local and Remote Maintenance Interfaces for the monitoring parameter specified.

#### 3.2.3.3.2.7 Reset (ID = 15)

The reset parameter **shall**:

a. Have two values: Warm Reset and Factory Reset.

b. Cause the GBT to transition to the Power Up state (and initiate Power Up sequence) after two Reset (Warm Reset) control parameters are received within 1 second.

c. Restore all control parameters to their default value and cause the GBT to clear the link and then to transition to the Power Up state (and initiate Power Up sequence) after two Reset (Factory Reset) control parameters are received within 1 second.

#### 3.2.3.3.2.8 Power Down (ID = 16)

If implemented, the Power Down parameter **shall** force the GBT into the OFF state.

#### 3.2.3.3.2.9 Software Upload Enable/Disable (ID = 20)

The software upload enable/disable parameter **shall**:

a. Enable the GBT equipment to upload operational software to support the programmability requirements of Sections 3.2.3.3.2.11.

b. Have two discrete values: Enable Upload and Disable Upload.

c. Have a default value of Disable Upload.

#### 3.2.3.3.2.10 Software Upload (ID = 21)

The software upload parameter **shall**:

a. Communicate blocks of the new operational software executable image to reprogram the GBT to support the programmability requirements of Section 3.2.3.3.2.11

b. Be ignored unless the Software Upload Enable/Disable parameter indicates that an upload is enabled.

c. Not include the Binary Data in the Control reply message.

d. Have Three Fields: Block Number, Total Blocks, Program Binary Block (variable length).

#### 3.2.3.3.2.11 Switch Software Version (ID = 22)

The switch software version parameter **shall**:

a. Indicate to the GBT equipment to reboot to the alternate stored software image provided in the procedure of Section 3.2.3.3.2.10.

b. Cause the GBT to transition to the Power Up state and begin operation using the alternate software image (and initiate Power Up sequence) after two Switch Software Version control parameters are received within 1 second.

c. Allow repeated switching between the primary and alternate software images.

#### 3.2.3.3.2.12 Test Mode (ID = 25)

The Test Mode parameter **shall**:

a. Establish the GBT in special test modes that support testing of transmitter and receiver performance per Sections 3.2.3.2.2 and 3.2.3.2.3.

b. Have three discrete values: Loopback test mode, Sensitivity test mode, and Test mode OFF.

c. Have a default value of Test mode OFF.

#### 3.2.3.3.2.13 ADS-B Test Message Level (ID = 26)

When in the Sensitivity test mode, the GBT **shall** support control of the level of the ADS-B Test message.

### 3.2.3.4 GBT Monitoring and Reporting

a. The GBT monitoring function **shall** perform real-time system performance monitoring and provide real-time system performance reporting when the GBT is in the online state.

b. There **shall** be three instances where monitoring messages are sent to the Local and Remote Maintenance Interfaces:

   1. Upon request via a Control message with parameter ID = 5.

   2. When an alert or alarm threshold is crossed, and

   3. When a monitored parameter returns to a value within the normal range.

c. The alert or alarm status messages **shall** be sent within an average of 2 seconds over any 15 minute period and a maximum time of 4 seconds of when the parameter being monitored crosses the threshold level.

#### 3.2.3.4.1 Non-Congesting Monitoring

a. The GBT **shall** monitor automatically on a continuous basis without blocking or delaying operational communications and management and without the need for the insertion of an external command.

b. The GBT monitoring **shall** not cause the GBT function to degrade below requirements during operation of the system.

c. Regardless of the frequency of alarm and alert status messages, the GBT monitoring **shall** not prevent the reception and processing of commands.

#### 3.2.3.4.2 Alarm/Alert Monitoring Suppression

a. The GBT equipment **shall** suppress alarm and alert status messages to the Local and Remote Maintenance Interfaces upon command.

b. The GBT equipment **shall** send an alert event acknowledging the command to suppress alarm and alert status messages before suppressing alarm and alert monitoring messages.

#### 3.2.3.4.3 Alarm/Alert Processing

a. The GBT parameters to be monitored **shall** be described by three monitor parameter states:

   Normal
   Alert
   Alarm

b. The monitored parameter states **shall** be defined by a range of values that are adjoined such that the value range of the alert state is bordering on the normal state at one end of its range and the alarm state on the other side of its range. Figure 3-6 illustrates Normal, Alert and Alarm Range for a Parameter that has both an upper and lower alert and alarm range.

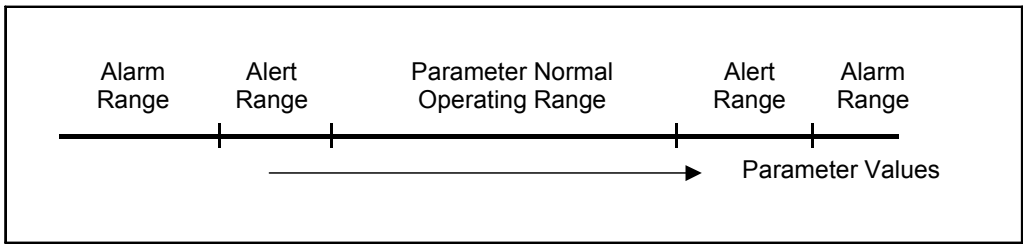



**Figure 3-6 Normal, Alert and Alarm Range for a Parameter**

c. A monitored parameter **shall** change state when the monitored parameter value transitions from a value within one range to a value within another range, if applicable for the parameter.

d. The GBT **shall** determine the change between normal state, alert state, and alarm state of GBT status parameter by comparing data to pre-established thresholds.

e. The GBT **shall** apply a discriminating function (hysteresis) at the boundaries of the ranges to minimize the declaration of alarms and alerts generated under monitored parameter transient conditions.

f. The GBT **shall** automatically declare an alert event when a monitored parameter and/or element status changes to a value that is outside the normal range but within the alert range.

g. The alert event **shall** be reported once per occurrence.

h. The GBT **shall** not generate spurious alert events in any state or transition.

i. The GBT **shall** automatically declare a return to normal event when a monitored parameter and/or element status that was previously outside the normal range changes to a value that is inside the normal range.

j. The return to normal event **shall** be reported once per occurrence.

k. The GBT **shall** automatically declare an alarm event when a monitored parameter and/or element status changes to a value crossing from the normal or alert range to the alarm range.

l. The alarm event **shall** be reported once per occurrence.

m. The GBT **shall** not generate spurious alarm events in any state or transition.

n. The GBT **shall** automatically declare a state change event when the value changes for a monitored parameter and/or element status that indicates a configuration or mode change to the GBT.

o. The GBT State change event **shall** be reported once per occurrence.

#### 3.2.3.4.4 GBT Monitoring Parameters

a. The GBT equipment **shall** monitor the parameters summarized in Table 3-15.

b. An event notification or request for data **shall** be processed within an average of 2 seconds over any 15-minute period and a maximum time of 4 seconds.

**Table 3-15 GBT Monitoring Parameters**

| ID | Monitoring Parameter | Arguments (if applicable) | Monitored Values | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Min | Max | Step | Tolerance (Acceptable Error) | Alert Values | Alarm Values |
| 1 | **GBT Configuration Items:** Current setting for GBT Configuration items | The specific Configuration Item requested (ID=1.x) | Current setting in use by the GBT | | | N/A | Alert on acceptance of new value with Item and new value | N/A |
| 4 | **GBT State**: The GBT State parameter indicates that the GBT is in one of four states: Online, Offline, Recovery or Fail. | N/A | One of 4 discrete values<br>-Off Line<br>-On Line<br>-Recovery<br>-Fail | | | N/A | Alert on State change (other than to Fail) | Alarm on Fail |
| 11 | **Suppress Alert/Alarm Setting**: The Suppress Alarm/Alert Setting parameter indicates whether Alarms and Alerts are suppressed or enabled | Monitoring Parameter | Two discrete values:<br>-Suppress,<br>-Normal | | | N/A | N/A | N/A |
| 20 | **Software Upload Setting**: The Software Upload Setting parameter indicated whether software uploading is prohibited or enabled | N/A | Two discrete values:<br>-Enable Upload,<br>-Disable Upload | | | N/A | N/A | N/A |
| 23 | **Software Version**: The Software Version parameter indicates the current version of the software active, as well as the standby software version. | N/A | 1 | 255 | 1 | 0 | N/A | N/A |
| 31 | **Receiver Status** | N/A | "Normal" or "Alarm condition" (i.e., fault detected) | | | N/A | N/A | On Alarm condition |
| 32 | **Transmitter Status** | N/A | "Normal" or "Alarm condition" (i.e., fault detected) | | | N/A | N/A | On Alarm condition |
| 33 | **Discard Event**: Alarm issued when either the ADS-B, TIS-B or Uplink Data Block discard Data Items in the Status Report are non-zero. | N/A | N/A | N/A | N/A | N/A | N/A | Alarm when any discard count in Status report is non-zero |
| 53 | **In-Service Time**: The In-Service Time parameter indicates the number of hours the GBT component has been powered. | N/A | 0 hrs | $2^{24} - 1$ hrs | 1 hr | +/- 1 hr | N/A | N/A |
| 55 | **Transmit Antenna VSWR**: The Transmit Antenna VSWR parameter indicates whether the VSWR of the transmit antenna is within an acceptable operating range. | Three Discrete Values: Normal, Alert, Alarm | N/A | N/A | N/A | N/A | Alert (reflected power is >9.5 dB below Output Power, i.e., VSWR is > 2:1 but less than 4:1) | Alarm (reflected power is >4.5 dB below Output Power, i.e., VSWR is >= 4:1) |
| 56 | **Transmitter Timeout**: Alarm to indicate a condition where the GBT transmitter has exceeded duty cycle limits resulting in automatic transmitter shutdown. | N/A | NORMAL or ALARM | | | N/A | N/A | ALARM on transmitter timeout |
| 57 | **Measured Power Output**: The Measured Power Output parameter indicates the current, actual RF transmission power at the GBT RF output. This measurement is only available during the Loopback test mode when the GBT is in the Offline state | Power in dBm | 30 dBm | 50 dBm | 0.5 dB | +/- 1 dB | N/A | N/A |
| 91 | **GBT Timing Status (TFOM):** The status of the integral or external timing source which ever is selected in the GBT configuration. | N/A | 1 | 10 | 1 | 0 | 4 | ≥5 |
| | | | | | | | | |

Shaded rows indicate monitor parameters that are also reflected in the Status report.

#### 3.2.3.4.4.1 GBT Configuration Items (ID = 1.1 through 1.15)

The GBT **shall** provide the current setting for the Configuration Item specified.

#### 3.2.3.4.4.2 GBT State (ID = 4)

The GBT state parameter **shall**:

a. Indicate the GBT equipment is in one of four states as per Section 3-15, Id. 4.

b. Be one of 4 discrete values: Offline, Online, Recovery or Fail.

c. Have an alarm value if transition to Fail state.

d. Have an alert value for other state transitions.

#### 3.2.3.4.4.3 Suppress Alarm/Alert Setting (ID=11)

The suppress alarm/alert Setting parameter **shall**:

a. Indicate the setting of the Suppress Alarm/Alert parameter.

b. Be one of two discrete values, either “Suppress” or “Normal”.

#### 3.2.3.4.4.4 Software Upload Setting (ID=20)

The software upload setting parameter **shall**:

a. Indicate the setting of the Software Upload parameter.

b. Be one of two discrete values, either “Enable Upload” or “Disable Upload”.

#### 3.2.3.4.4.5 Software Version (ID = 23)

The software version parameter **shall**:

a. Indicate the current version of the software active in the GBT equipment, as well as the version number of the standby software version.

b. Be one of 255 discrete values for each field.

c. Have a minimum value of 1.

d. Have a maximum value of 255.

e. Use a value of 0 to indicate an invalid or non-existent version.

f. Have a resolution (step size) of 1.

#### 3.2.3.4.4.6 In-Service Time (ID = 53)

The in-service time parameter **shall**:

a. Indicate the number of hours the GBT equipment has been continuously powered.

b. Be provided in hours.

c. Have a minimum value of 0 hours.

d. Have a maximum value of $2^{24}$-1 hours.

e. Have a resolution (step size) of 1 hour.

f. Have a tolerance (acceptable error) of +/- 1 hour.

g. Provide a reset (to ZERO) by a reset action accessible only locally.

*Note: This reset need not be part of the Local Maintenance interface.*

#### 3.2.3.4.4.7 Receiver Status

The receiver status parameter **shall** indicate the GBT's receiver as either in a "normal" condition (no fault detected by the GBT) or an "alarm" condition (fault detected by the GBT).

#### 3.2.3.4.4.8 Transmitter Status

The transmitter status parameter **shall** indicate the GBT's transmitter as either in a "normal" condition (no fault detected by the GBT) or an "alarm" condition (fault detected by the GBT).

#### 3.2.3.4.4.9 Discard Event

The discard event parameter **shall** indicate:

a. the "normal" condition when all discard counts are zero in a Status reporting interval.

b. the "alarm" condition when any discard counts are non-zero in a Status reporting interval.

#### 3.2.3.4.4.10 Transmit Antenna VSWR (ID = 55)

The transmit antenna VSWR parameter **shall**:

a. Be one of three discrete values as given below:

| Condition | Relative Power | VSWR |
|---|---|---|
| NORMAL | Reflected power is at most 9.5 dB below the forward power | 2:1 or less |
| ALERT | Reflected power is between 4.5 and 9.5 dB below the forward power | Between 2:1 and 4:1 |
| ALARM | Reflected power is 4.5 dB or less below the forward power | 4:1 or greater |

#### 3.2.3.4.4.11 Transmitter Timeout (ID = 56)

The Transmitter Timeout parameter **shall** report a Transmitter Timeout Alarm when the transmitter duty cycle exceeds the limit established in Section 3.2.2.2.4.

#### 3.2.3.4.4.12 Measured Power Output (ID = 57)

The measured power output parameter **shall**:

a. Measure the average RF power at the Air Interface during transmission of a Ground Uplink loopback message.

b. Be a power level in dBm.

c. Have a minimum value of 30 dBm.

d. Have a maximum value of 50 dBm.

e. Have a resolution (step size) of 0.5 dB for all GBT transmitter configurations.

f. Have a tolerance (acceptable error) of ±1 dB for all GBT transmitter configurations.

#### 3.2.3.4.4.13 GBT Timing Status (ID = 91)

The GBT Timing Status parameter **shall**:

a. Be based on the Time Figure of Merit (TFOM) parameter derived by the integral or external time source (whichever is selected via the GBT configuration).

b. Be three discrete values:

| | |
|---|---|
| NORMAL | TFOM <= 3 |
| ALERT | TFOM = 4 |
| ALARM | TFOM >= 5 |

*Note: The range and meaning of TFOM values is as follows:*

| *TFOM Value* | *Timing Uncertainty* |
|---|---|
| *1* | *<= +/- 1 nanosecond* |
| *2* | *<= +/- 10 nanoseconds* |
| *3* | *<= +/- 100 nanoseconds* |
| *4* | *<= +/- 1microsecond* |
| *5* | *<= +/- 10 microseconds* |

**3.2.3.5 Event Logging Requirements**

The GBT **shall** log the following events:

a. State change events, defined as the transition from one state to any other state.

b. Log-in/Log-out events, defined as the initiation/termination of a Control Session.

c. Control events, defined as receipt of any control parameter command except ID#5, Real Time Read back, and ID#6, event Log Read back.

d. Failure events, defined as the detection of any failure.

e. Alarm/Alert/Return to Normal events, defined as a monitored parameter crossing of any active alarm or alert threshold.

**3.2.3.5.1 State Transition Log Entry**

a. For state transitions, the GBT **shall** log the:

Event Type as State Change.
FROM state.
TO state.
Date/time of event to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The Event Type field **shall** contain a coded indication of the event type.

**3.2.3.5.2 Log-In / Log-Out Log Entry**

a. For Log-in/Log-out events, the GBT **shall** log the:

Event Type as Log-in/Log-out.
Date/time of event to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).
Session Action.
User Identification.
User Terminal Identification.
Authentication Result.

b. The Session Action field **shall** indicate whether the Log-In/Log-Out Event was a Login, Commanded Log Out, or Automatic Log-Out.

c. Authentication Result field **shall** indicate whether the Digital Signature associated with the Log- In was authenticated or rejected.

#### 3.2.3.5.3 Control Event Log Entry

a. For Control events, the GBT **shall** log the:

Event Type as Control.
Control Parameter ID.
Control Parameter BEFORE value.
Control Parameter value except software update payload.
Date/time (of Control command receipt) to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).
User Identification.
User Terminal identification.
GBT Response.

b. The GBT Response field **shall** indicate whether the GBT accepted or rejected the control parameter command.

c. If the GBT rejects the control parameter command, the GBT Response field **shall** contain the error code.

#### 3.2.3.5.4 Failure Event Log Entry

a. For Failure events, the GBT **shall** log the:

Event Type as Failure.
FROM state.
TO state (Recovery or Failed).
Failure code.
Date/time (of Failure) to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The Failure code field **shall** contain text or numeric codes to indicate the specific failure type.

#### 3.2.3.5.5 Alarm/Alert/Return to Normal (RTN) Log Entry

a. For Alarm/Alert/RTN events, the GBT **shall** log the:

Event Type as Alarm/Alert/RTN.
Monitored Parameter ID.
Monitored Parameter value.
Date/time of event to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The Event Type field **shall** be coded to indicate whether the event was an Alarm, an Alert or a Return to Normal.

### 3.2.3.5.6 GBT Event Log Maintenance

a. The GBT **shall** log at least 1000 events, in any combination of events, and log events on a First In, First Out basis.

b. The GBT log and log entries **shall** be retained while the GBT is any state, including OFF state, and through any transition, including power loss and restoral, for the life of the GBT equipment.

### 3.2.3.5.7 Event Log Read back

The GBT **shall** reply to a Control Parameter #6, Event Log Read back with the Event Log entries that match the Filter and Qualifier criteria, as follows:

| FILTER | QUALIFIER | GBT reads back: |
|---|---|---|
| All | | all event log entries |
| All | Date/Time | all event log entries since Date/Time |
| State Change | | all state change event log entries |
| State Change | Date/Time | all state change event log entries since Date/Time |
| Control | | all control event log entries |
| Control-DT | Date/Time | all control event log entries since Date/Time |
| Control-ID | ID | all control event log entries with Control parameter ID specified |
| Failure | | all failure event log entries |
| Alarm/Alert/RTN | | all alarm/alert/RTN event log entries |
| Alarm/Alert/RTN-DT | Date/Time | all alarm/alert/RTN event log entries since Date/Time |
| Alarm/Alert/RTN-ID | ID | all alarm/alert/RTN event log entries with alarm/alert/RTN set against Monitored parameter ID specified |
| Log-In/Log-Out | | all log-in/log-out event log entries |
| Log-In/Log-Out | Date/Time | all log-in/log-out event log entries since Date/Time |
| Security | | all security log entries (see Section 3.2.3.7.3.d) |

### 3.2.3.6 GPS Satellite Observation Log Requirements

a. Once per minute, the GBT **shall** log the following GPS satellite observation data:

1. List of Tracked Satellites including the following data for each:

   Satellite Anti-Spoof Flag.
   Satellite Unhealthy Flag.
   Satellite Inaccurate Flag.
   Satellite Parity Error Flag.
   Elevation angle of each satellite above the horizon.
   Azimuth angle of each satellite from north (0-359°).
   Satellite ID.
   Satellite Signal To Noise Ratio (SNR).

2. Date/time of satellite observation to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The GBT **shall** be capable of holding at least 1000 GPS satellite observations on a First In First Out basis.

c. The GPS Satellite Observation log and log entries **shall** be retained while the GBT is in any state, including the OFF state, and through any transition, including power loss and restoral, for the life of the GBT equipment.

d. The GBT **shall** reply to a Control Parameter #7 GPS Satellite Observation Read back that matches the Filter and Qualifier criteria, as follows:

| FILTER | QUALIFIER | GBT reads back: |
|---|---|---|
| All | | all log entries |
| All | Date/Time | all log entries since Date/Time |

### 3.2.3.7 INFOSEC Requirements

The GBT equipment will meet the appropriate technical, administrative, physical, and personnel security requirements to ensure the integrity, availability, and confidentiality throughout the service period of performance.

#### 3.2.3.7.1 Verification

a. The GBT **shall** verify the authenticity, integrity and time validity of the digital signed information received via the Local and Remote Maintenance Interfaces.

b. The digital signature algorithm that performs this verification **shall** correspond to at least one of the algorithms defined in FIPS 186-2.

c. The digital signature function **shall** meet or exceed security level 1 as defined in FIPS 140-1.

d. The digital signature function **shall** be validated according to FIPS 140-1 by an accredited FIPS 140-1 testing laboratory.

#### 3.2.3.7.2 Keys

a. The GBT **shall** provide storage for 10 public keys, any of which may be used in verifying the digital signature defined in 3.2.3.7.1.

b. The storage for public keys **shall** be in non-volatile memory and be maintained through power loss and restoral.

c. The GBT **shall** provide a mechanism to add and delete public keys via the Local and Remote Maintenance Interfaces.

#### 3.2.3.7.3 Security Procedures

a. All control parameter commands, except ID#5 Real Time Read back, **shall** be accepted only if the requesting device establishes a Control session, by providing a valid digitally signed authorization key ("security key") as defined in FIPS PUB 140-1.

*Note: The Real Time Read back control parameter is the only control parameter that the GBT will accept when no Control session has been established.*

*Note: The "security key" will consist of a FAA-generated digital signature of an FAA-selected data field. The FAA-selected data field may be unique to each User Terminal. The security key will be supplied through the Local or Remote Maintenance Interface.*

b. All control parameter commands, except ID#5 Real Time Read back, received without establishment of, or outside of, a Control session, or are associated with a security key that fails digital signature verification, **shall** be rejected.

c. The GBT **shall** receive and authenticate the security key each time a login is attempted through the Local and Remote Maintenance Interfaces.

d. The GBT **shall** maintain a log of security keys and signatures so that an access history can be tracked. This log **shall** be permanent and unalterable and contain a minimum of the most recent 500 occurrences. The security log **shall** include the following:

1. Authorized access and by which security key
2. Unauthorized access attempts
3. Log or function accessed
4. Change date and time of software
5. Change date and time of security key codes

*Note: Security procedures apply to Control sessions only. These security requirements apply only to the GBT processing of control parameters. These security requirements do not apply to the GBT's Ground Interface or Air Interface.*

#### 3.2.3.7.3.1 Software Upload Security

a. Software uploads that are not digitally signed or contain an invalid digital signature **shall** be rejected.

*Note: The Software Upload control parameter (ID#21) message will contain, in the last delivered program binary block, a digital signature appended to the software binary image as a signature specifically for the software image contained in the program binary blocks.*

b. If the Software Upload capability is still enabled when a user's control session is ended, the Software Upload parameter **shall** be set to disable

#### 3.2.3.7.4 Boot Cycle

The GBT boot cycle or equivalent **shall** be secured so the possibility of an unintentional switch of the GBT operating software during the boot cycle does not occur.

#### 3.2.3.7.5 Physical Security

a. The GBT equipment **shall** utilize tamper-proof seals, an example being of those used by quality inspectors, to indicate the physical security of any item (LRU) integral to the GBT equipment.

*Note: FIPS PUB 140-1, paragraph 4-5, requires this.*

b. The physical security of the end item GBT will be encompassed by the FAA installation site security.

### 3.2.3.8 Vendor Built In Test

Any Vendor developed built-in test (BIT) capability for the GBT **shall** be provided to the FAA.

### 3.2.3.9 GBT Failure Detection and Reporting

The GBT **shall** detect and report critical equipment failures to the Local and Remote Maintenance Interfaces automatically when the GBT is in the Offline and Online states and during Recovery.

*Note: See Section 5.9 for definitions of critical and non-critical equipment failures.*

## 3.3 Interfaces

### 3.3.1 Air Interface

a. The GBT **shall** support two Air Interface configuration options:

   1. Combined transmit and receive through a single GBT antenna port.

   2. Separate GBT antenna ports for transmit and receive.

b. The Air Interface **shall** be configurable to either Air Interface option by an on site technician without opening the GBT.

c. Air Interface connectors **shall** be 50 ohm coaxial type N female.

d. The transmit/receive switch **shall** be integral to the GBT

*Note: It may desirable in some installations to use a transmit antenna with minimal gain where many GBTs are sited. This controls co-channel interference better. See Figure 3-7 for one possible implementation for configuring the air interface option.*

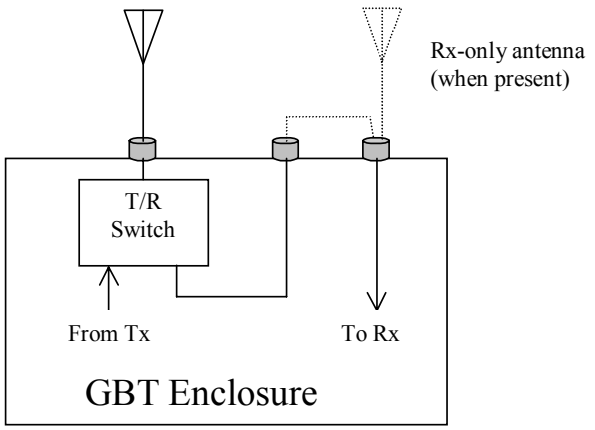



**Figure 3-7. An Example Implementation of the Air Interface Option**

### 3.3.2 Ground Interface

There **shall** be three Ground Interface connector options: Two for Serial and one for Ethernet.

#### 3.3.2.1 Serial

The GBT **shall** support synchronous and asynchronous Serial interface configurations.

##### 3.3.2.1.1 Asynchronous

This interface option **shall** be supported with a female DB9 RS-232.

##### 3.3.2.1.2 Synchronous

This interface option **shall** be supported with a female DB25 (EIA-530 pinout) EIA/RS-422.

#### 3.3.2.2 Ethernet

The Ethernet interface option **shall** be supported with a female RJ-45 for supporting Cat 5 wire media.

### 3.3.3 External Timing Input

a. An external timing interface **shall** be provided and consist of a Precise Time and Time Interval (PTTI) interface in accordance with ICD-GPS-060, Revision B.

b. PTTI signals **shall** include 1 PPS, BCD Time Code, and Timing Fault Discrete.

c. The 1 PPS physical interface **shall** be 50 ohm, BNC.

d. The BCD Time Code and Timing Fault Discrete signals **shall** share a common DB9 female connector.

*Note: This external timing interface is required to support installations where use of an external timing source may be preferable to the integral GPS source.*

### 3.3.4 Electrical Input Power

a. Electrical input power connectors **shall** be of the male, two-conductor type polarized for DC inputs.

b. The power connector **shall** conform to FAA-G-2100G, Section 3.3.1.3.3. Commercial equivalent connectors are acceptable if available.

### 3.3.5 Remote Maintenance Interface

The Remote Maintenance interface **shall** be a female DB9, RS 232 serial interface.

### 3.3.6 Local Maintenance Interface

The Local Maintenance interface **shall** be a female DB9, RS 232 serial interface.

### 3.3.7 Integral GPS RF Connector

The GPS RF connector **shall** be a 50-ohm coaxial type TNC female.

## 3.4 Construction Requirements

### 3.4.1 Physical Requirements

#### 3.4.1.1 Reserved

#### 3.4.1.1.1 Workmanship

Workmanship **shall** be in accordance with the requirements of this specification, FAA-G-2100G, and MIL-HDBK-454, Guideline 9.

#### 3.4.1.1.2 Equipment Size

a. The GBT equipment **shall** be constructed to allow for installation into a standard 19-inch equipment rack (EIA 3U).

b. Mounting hole dimensions, spacing, and panel size **shall** be as specified in EIA-310E (old designation EIA-RS-310D).

c. The GBT equipment **shall** not exceed 3 units in height and 19 inches in depth. (1 unit is equal to 1.75 inches).

d. More than one chassis is permissible, however the 3-unit total height limitation still applies.

e. The GBT equipment **shall** not protrude greater than 2 inches from the front mounting plane.

#### 3.4.1.1.3 Equipment Weight

The individual GBT rack mounted equipment chassis weight **shall** not exceed 37 pounds for each unit in accordance with FAA-G-2100G, Section 3.3.6.3, to be lifted by one person.

#### 3.4.1.1.4 Equipment Slides

a. The GBT equipment **shall** allow access to control, monitoring and maintenance activities with the equipment bolted to the FAA standard 19-inch equipment rack.

b. The GBT equipment **shall** include slides that:

1. extend the GBT equipment the full length of the GBT equipment.

2. have end-stops that prevent over-extension,

3. meet FAA-G-2100G, Section 3.1.2.4.3,

4. have the slide component attached to the GBT be separable, without tools, from the slide-component that will be attached to the equipment rack.

#### 3.4.1.1.5 Nameplates

Each GBT equipment or subsystem furnished **shall** have a nameplate mounted on the front of the chassis as specified in FAA-G-2100G, Section 3.3.3.1 and associated Subsections.

#### 3.4.1.1.6 Pin Layout Identification

a. Numbering or lettering on, or immediately adjacent to, the connectors **shall** identify all connector pins.

b. All cable connectors furnished on the equipment for making external connections **shall** be clearly identified on the plug-in side by labels descriptive of their specific function and by the proper reference designation. Non-COTS cable connectors **shall** be mechanically keyed to prevent incorrect installation and hookup. The mating connector part (connector or plug) that is electrically energized **shall** contain female contacts, unless approved by the FAA. All cable connectors **shall** be mechanically retained in place, excluding internal power cables. Connectors **shall** comply with paragraph 3.3.1.3.3 of FAA-G-2100G.

#### 3.4.1.1.7 GBT Installation/Removal

The GBT equipment **shall** be constructed to be installed, removed, and reinstalled with a minimum of common tools and without extensive disassembly.

#### 3.4.1.1.8 GBT Set-Up

The GBT equipment **shall** be initially set up and adjusted under normal operating conditions (see Section 3.4.3.1), following the procedures in the technical instruction book.

#### 3.4.1.1.9 GBT Warm-up

The GBT equipment **shall** meet the requirements of full power operation within 90 seconds of turn on.

#### 3.4.1.1.10 Thermal Protection

a. The GBT equipment **shall** protect itself from damage during any over-temperature/over-heat condition. An over-heat/over-temperature condition is any GBT operating temperature that exceeds 50° C (122° F).

b. The GBT **shall** operate without degradation within the temperature range specified in Table 3-17.

#### 3.4.1.1.11 Shock and Vibration Protection

a. Shock and vibration protection **shall** conform to MIL-STD-810, Method 516.5, and Procedure VI - Bench Handling.

b. In all cases specified in a. above, no fixed part **shall** become loose.

c. No movable part or permanently set adjustment **shall** shift its setting or position.

d. No degradation in GBT performance **shall** occur under the environmental service and operational conditions specified herein.

#### 3.4.1.1.12 Grounding, Bonding, and Shielding

The GBT equipment grounding, bonding, and shielding protection **shall** be as specified in FAA-STD-020B, Sections 3.8, 3.9, and 3.10, and associated Subsections.

#### 3.4.1.1.13 Lightning Protection

All GBT equipment **shall** be protected from the effects of lightning as specified in FAA Order 6950.19, Chapter 2, Section 6. The subsystem antenna assemblies **shall** be in compliance with NFPA-780, Lightning Protection Code.

#### 3.4.1.1.14 Acoustical Noise Criteria Requirement

Sound pressure and acoustic noise levels generated by the GBT equipment in normal operation **shall** not exceed the limits as specified in FAA-G-2100G, Section 3.3.6.1, Subsection c.

#### 3.4.1.1.15 Materials, Processes, and Parts

a. Selection of materials **shall** be consistent with the requirement of economically producing a system that performs its specified functions with ruggedness and durability for a 20-year operational period.

b. The components **shall** be equal to or better than those components meeting the applicable EIA standards and suitable for the purpose intended.

c. All parts used in the GBT equipment **shall** be operated within their electrical ratings and the environmental requirements of this specification.

d. The materials chosen **shall** be non-nutrient to fungus and insects, non-hygroscopic and not adversely affected by the environmental conditions specified herein.

e. All electrical, electronic or electromechanical parts used in the GBT equipment **shall** be new. Recycled metals or plastics may be used for mechanical or structural parts as appropriate.

##### 3.4.1.1.15.1 Ferrous Materials

Ferrous materials, if used, **shall** be corrosion-resisting types.

##### 3.4.1.1.15.2 Arc-Resistant Materials

Arc-resistant materials **shall** be used for insulation of electrical power circuits where arcing is likely to occur.

##### 3.4.1.1.15.3 Dissimilar Metals

Selection and protection of dissimilar metal combinations **shall** be in accordance with FAA-G-2100G, Section 3.3.1.1.1 and MIL-STD-889.

#### 3.4.1.1.15.4 Fibrous Material

Fibrous material **shall** not be used.

#### 3.4.1.1.15.5 Flammable Materials

Flammable materials **shall** not be used without prior FAA approval in accordance with FAA-G-2100G, Section 3.3.1.1.3.

### 3.4.1.1.16 Antenna Assembly Materials and Finish

All Antenna Assemblies, including all exterior RF wires and waveguides, **shall** utilize materials, coatings and finishes that are inherently resistant to a corrosive environment. The latter includes environments with high salt content (5 percent salt concentration by weight) and/or with industrial pollutants of particulates and sulfur and/or nitrogen oxides at maximum allowable ambient concentrations. Certain materials for any exposed portion(s) of the antenna radiating elements (reference paragraph 3.3.5.6 of FAA-G-2100G) may require written approval of the FAA. All electrical performance requirements of this specification **shall** be met with finish applied.

### 3.4.1.1.17 Safety

a. A GBT equipment malfunction **shall** in no way contribute to the destruction of the equipment or any part of its environment.

b. Safety **shall** conform to the requirements of FAA-G-2100G, Section 3.3.5 and associated Subsections.

c. Any exposed or accessible area of the GBT equipment that could pose a thermal contact hazard, as defined in the FAA Human Factors Guide, section 12.10.1, **shall** be clearly labeled as a Thermal Contact Hazard.

### 3.4.1.1.18 Removable Parts and Mating Connectors

a. The GBT equipment **shall** permit removal of all modules and printed circuit assemblies without causing damage to the modules, printed circuit assemblies or any other equipment. Mechanical interlocks or keyed elements may be used to disconnect power temporarily from modules or components during removal or insertion. The GBT system **shall** use mechanical means (interlocks or keys) to prevent insertion or connection of plug-in modules that are incorrectly oriented. When redundant modules are incorporated into the GBT equipment, it **shall** be possible to remove any one of the redundant modules without interruption of service. All GBT equipment **shall** meet accessibility requirements defined in section 3.1.2.4 of FAA-G-2100G.

b. When two or more pieces of equipment require interconnection, the necessary mating connectors (except coaxial) **shall** be supplied for both the GBT and associated equipment that interfaces with the GBT in accordance with FAA-G-2100G, Section 3.1.2.1.

### 3.4.1.2 Controls

#### 3.4.1.2.1 Detents

The controls with an "OFF" position **shall** have a detent or equivalent in the ON position to prevent inadvertent operation.

#### 3.4.1.2.2 Adjustment Range

a. The adjustment range of the GBT equipment operation and maintenance controls **shall** be constructed to preclude damage to the equipment or its subassemblies when adjusted to the limits of the control travel.

b. The range of control **shall** be constructed to reduce the sensitivity and criticality of the adjustment task to the maximum extent possible.

#### 3.4.1.2.3 Power Switches/Power On Indicators

a. The GBT equipment **shall** have a front panel mounted DC power switch.

b. A DC Power On indicator **shall** be located adjacent to the DC Power switch, and be lit when DC Power is applied to the GBT and the DC Power Switch is in the On position.

c. Power switches **shall** be protected from inadvertent action (operation).

#### 3.4.1.2.4 Front Panel Display

a. The GBT equipment front panel **shall** provide separate visual indicators (e.g., LEDs) for quick-look status.

b. The GBT visual indicators **shall** provide visual indications on the front panel as follows:

1. A red indicator that is lit in the event of a alarm or when the GBT is in Failed state.

2. An amber indicator that is lit in the event of an alert.,

3. A white indicator, which is lit when DC power is applied to the GBT.

4. A green indicator that is lit when the GBT is in the Online state, off when in the Offline state, and flashes when in the Recovery state.

5. Green indicator lights for RF Transmit, RF Receive, Data Transmit, and Data Receive.

6. The visual indications for failure events, alarm events and alert events **shall** remain until the failure, alarm or alert is cleared by the respective Return to Normal.

7. The visual indicators **shall** be viewable for at least +/- 60 degrees off horizontal or vertical axis and be clearly visible from 10 feet away in a brightly lit room.

#### 3.4.1.2.5 Functions and Labeling

a. Labeling **shall** be permanent, legible, and mounted so that the data are visible to personnel without the need to disassemble the part or adjacent functional or structural parts.

b. Connectors **shall** be identified on the plug-in side by labels that describe their specific functions.

c. All fuse positions **shall** be marked with the rated current capacity, voltage rating, and type of fuse to be used.

d. Delayed action fuses **shall** have the additional designation "SLOW".

e. All fuse markings **shall** be on the insertion side, so as to be visible when replacing fuses.

f. The following functions and corresponding labels **shall** be available on the equipment as specified in Table 3-16:

**Table 3-16 GBT Functions and Labeling**

| Functions | Labeling |
|---|---|
| DC Power ON/OFF Switch | DC PWR ON/OFF |
| DC Power ON Indication Light | DC PWR - White |
| Alert Indication Light | Amber |
| Alarm/Failed Indication Light | Red |
| Online/Offline/Recovery Indication Light | ONLINE (on) / OFFLINE (off) /RECOVER (flashing) - Green |
| RF Transmit Indication Light | RF TRANSMIT - Green |
| RF Receive Indication Light | RF RECEIVE - Green |
| Data Transmit Indication Light | DATA TRANSMIT - Green |
| Data Receive Indication Light | DATA RECEIVE - Green |
| DC Fuse Holder/Circuit Breaker AMP (TBS) | 24 VDC/ (TBS) Amps (Slow*) |
| DC Input Power Connector | 24 +/- 6 VDC |
| GBT Antenna RF Out Connector | GBT RF |
| GBT Antenna GPS Connector | GPS ANT |
| Local Maintenance Interface Connector | LOCAL MAINT INTERFACE |
| Remote Maintenance Interface Connector | REMOTE MAINT INTERFACE |
| ADS-B Test Message Output | ADS-B TEST MSG OUT |

* If applicable

### 3.4.1.3 GBT Identification (ID) Numbering

Each GBT **shall** have a permanent, non-changeable and unique identification (ID) number, which is marked on the exterior and visually accessible when the GBT is mounted in a standard 19-inch rack.

## 3.4.2 Electrical Requirements

### 3.4.2.1 Input Power Requirements

a. The GBT equipment **shall** meet the requirements of this specification with input voltage of 24 VDC ( ± 6 volts), negative ground.

b. The GBT equipment **shall** operate under varying conditions, such as slow variations of DC line voltage, within the range specified herein.

c. The GBT equipment **shall** operate without degradation of performance and automatically resume normal operation when subjected to partial or complete power interruptions and/or outages of up to 20 ms at a time in accordance with FAA-G-2100G, Section 3.1.1.7.

d. DC voltage input **shall** be from the rear of the GBT equipment, and when practical, be located on the lower right side of the GBT equipment as viewed from the rear.

e. The maximum current limits for the GBT equipment **shall** be 15 amperes for DC power.

f. The GBT equipment **shall** not sustain damage to or alteration of its equipment, nor cause false operation or false output, when DC power is outside its normal limits of operation, including total loss of power. If proper operations cannot be maintained due to power conditions, the GBT system **shall** cease operation. Automated means for startup after such stoppage **shall** be provided.

g. The GBT equipment electrical features **shall** meet the electrical power source requirements of FAA-G-2100G, section 3.1.1 and associated subsections. The power distribution design and implementation **shall** be in accordance with National Electric Code, NFPA-70, and FAA-C-1217F.

*Note: the vendor shall supply the actual average current values.*

#### 3.4.2.1.1 Power Cord

a. The equipment **shall** be provided with a removable six-foot, two-conductor DC power cord, matching with the respective connector on the GBT equipment.

b. Power connectors **shall** be compliant with paragraph 3.3.1.3.3.3 of FAA-G-2100G.

#### 3.4.2.2 Reverse Polarity Protection

The GBT equipment **shall** incorporate reverse polarity protection to prevent damage to the GBT equipment if the polarity of the 24 VDC input voltage is reversed.

#### 3.4.2.3 Circuit Protection

a. All GBT equipment input/output circuits **shall** include circuit protection, which prevents opens or shorts at the input/output terminals from damaging the equipment.

b. When the short or open is removed, circuit performance **shall** show no sign of performance degradation in accordance with FAA-G-2100G, Section 3.1.1.7.

#### 3.4.2.3.1 Current Overload Protection

a. The GBT equipment **shall** be protected to prevent damage from current overload as specified in FAA-G-2100G paragraph 3.1.1.6 and FAA-STD-020B.

b. Current overload protection for the GBT equipment **shall** be provided by fuses, circuit breakers, or other protective devices for the primary input DC circuit as specified in FAA-G-2100G, Section 3.3.1.3.2, 3.3.1.4.1 and associated Subsections.

#### 3.4.2.3.2 Protective Caps

Protective caps for mating with normally unmated or infrequently used connectors (i.e. test/diagnostic input/output connectors) on the GBT receiver and transmitter **shall** be provided in accordance with FAA-G-2100G, Section 3.3.1.3.3.4.

#### 3.4.2.3.3 Electrostatic Discharge Control

All circuits and components used in the GBT equipment that are susceptible to damage by ESD **shall** be protected as specified in FAA-G-2100G, Section 3.2.7 and FAA-STD-020B, Section 3.12.3.

#### 3.4.2.3.4 Surge Protection

Protective devices **shall** be provided as necessary to prevent damage to the equipment from surges on the DC power line or the signal/communications cables. The devices **shall** withstand repeated surges without damage or change in operating characteristics. The protective devices **shall** be in accordance with the applicable parts of Paragraphs 3.1 through 3.7 of FAA-STD-020B.

#### 3.4.2.3.5 Transient Protection

a. The GBT equipment **shall** be protected to prevent damage from electrical transients as specified in FAA-G-2100G, section 3.1.1.7, and FAA-STD-020B, section 3.7 and associated subsections.

b. The GBT system **shall** not produce false operational or maintenance signals resulting from intentional operation by operators or maintenance personnel. All GBT equipment **shall** comply with FAA Order 6950.19, Chapter 3, Section 6, and paragraph 3.1.1.7 of FAA-G-2100G. All supporting equipment **shall** not provide any false data during operation under the environmental conditions specified in Sections 3.4.2 and 3.4.3, inclusive.

### 3.4.2.4 Test Points

External test points, if applicable, **shall** be female BNC type connectors.

### 3.4.2.5 VSWR Protection

The GBT equipment **shall** not sustain permanent damage from infinite VSWR.

### 3.4.2.6 Loss of Input Voltage

The loss or variance of input voltage, including loss of voltage caused by activation of circuit protector devices, **shall** not cause or induce any damage to any component in the GBT equipment or other interfacing equipment.

### 3.4.3 Environmental Conditions

The GBT equipment **shall** be constructed of materials to withstand any combination of environmental and service conditions specified below without causing damage or degradation of performance below the requirements of this specification.

#### 3.4.3.1 Operating Conditions

##### 3.4.3.1.1 Indoor Operating Conditions

The GBT equipment **shall** be able to operate in a facility under the operating conditions specified in Table 3-15:

**Table 3-17 Indoor Operating Conditions**

| | |
|---|---|
| Temperature Range | -10° C to +50° C (+14°C to +122°F) |
| Relative Humidity | 5 to 90 percent (above 40°C (104°F), the relative humidity is based on the dew point of 40° C) |
| Altitude | -300 to 15,000 Feet |

##### 3.4.3.1.2 Outdoor Operating Conditions

a. Any external components of the GBT equipment **shall** be weather resistant and accessible for repair considering human factors criteria in accordance with FAA Human Factors Guide, Section 12.10.1.

b. Any vendor-provided GBT equipment located outdoors, such as GPS antenna, **shall** operate in environmental conditions as defined in FAA-G-2100G Standards, Section 3.2.1.1.2. An exception to the environment is that the lower end of the temperature range **shall** be as defined in MIL-STD-810F, Table C-I, for the entire set of conditions defined as SEVERE COLD (i.e. at -51° C (-60° F)). The equipment **shall** survive without deformation ice to 75mm thickness and hailstones up to 0.5 inches in diameter during the environmental conditions defined. Exceptions to these standards will be identified and are subject to FAA approval.

#### 3.4.3.2 Non-Operating Conditions

Non-operating conditions for the GBT equipment are those conditions affecting equipment in storage, in shipment, in the process of being installed at a site, and installed at a site but non-operating. The GBT equipment **shall** meet the requirements for non-operating conditions in Table 3-16:

**Table 3-18 Non-Operating Conditions**

| | |
|---|---|
| Temperature Range | -40° C to +70° C (-40° F to +158°F) |
| Relative Humidity | Up to 100 percent including condensation due to temperature changes |
| Altitude | -300 to 50,000 Feet |

#### 3.4.3.3 Equipment Ventilation and Cooling

a. The GBT front panel **shall** not present a thermal contact hazard to personnel in accordance with FAA Human Factors Guide, Section 12.10.1.

b. The GBT **shall** not require a ventilating or cooling fan.

### 3.4.4 Electromagnetic Compatibility Requirements

a. Electromagnetic emission and susceptibility of the GBT equipment **shall** not exceed the limits in MIL-STD-461 requirements CE-102, CE106, CS-101, CS-114, CS-115, CS-116, RE-102, RE103, RS101 and RS-103. Where conflict exists between "Ground Navy Procurement", "Ground Air Force Procurement", and "Ground Army Procurement", the "Ground Navy Procurement" takes precedence (MIL-STD-461, Table V).

b. The materials used for GBT equipment shielding **shall** be in compliance with the requirements of FAA-STD-020B, Section 3.10.

## 3.5 Quality Factors

### 3.5.1 Reliability

#### 3.5.1.1 Mean Time Between Failures

The predicted Mean Time Between Failures (MTBF) for the GBT equipment **shall** be not less than 26,280 hours (3 years). The MTBF pertains to the Critical Equipment Failure as defined in 5.2.9.2

### 3.5.2 Maintainability

a. The GBT equipment **shall** provide parameter adjustments for routine maintenance.

b. The GBT equipment *should* consist of the following minimum LRUs by approximate functional boundary as indicated below:

- RF Transceiver
- GPS Sensor
- All other functionality

#### 3.5.2.1 Mean Time To Repair

The Mean Time To Repair (MTTR) of the GBT equipment **shall** not be greater than 30 minutes at the site.

#### 3.5.2.2 Periodic Maintenance

a. The GBT equipment **shall** be configured so that periodic maintenance can be performed without disrupting other GBTs that are on-line.

b. Periodic maintenance intervals **shall** meet or exceed one year.

### 3.5.3 Service Life

The GBT equipment **shall** have a useful service life of at least 10 years under mission operating conditions for 24 hours per day, seven days per week with downtime for corrective and preventative maintenance not to exceed that necessary to satisfy the reliability, maintainability, and availability requirements of this specification.

### 3.5.4 Availability

The GBT **shall** have a minimum inherent availability threshold equal to 0.99995. Inherent availability is defined as MTBF/(MTBF+MTTR).

## 3.6 Flexibility and future services and capabilities

The GBT specified within the document does not represent the desired end-state GBT. Certain features and capabilities could not be specified at the time of writing of the specification because standards did not exist at the time or the capability was not yet mature enough, and/or cost and schedule constraints demanded that the capabilities be delayed to later builds.

### 3.6.1 Flexibility

It is desired that the GBT be designed taking into account the future services and capabilities listed in section 3.6.2 so the GBT does not require a later major redesign and replacement after they are initially fielded. The GBT *should* employ a modular hardware and software design that allows these future services and capabilities to be incorporated into it with minimal effort and cost.

### 3.6.2 Future Services, capabilities, and changes

Future services and capabilities may include but are not limited to the following:

1. Changes to the ADS-B and TIS-B definition, standards, and formats. Because ADS-B and especially TIS-B are still new evolving concepts, it is likely that changes to these concepts will occur.

2. RMM capabilities are likely to change and evolve as the FAA's national RMM system evolves.

# 4.0 QUALITY ASSURANCE PROVISIONS

## 4.1 Responsibility For Inspection

Not applicable

## 4.2 Special Tests And Examinations

Not Applicable

## 4.3 Requirement Cross Reference

The Contractor Verification Requirement Traceability Matrix provides a mapping of requirement "**shall**s". [this specification FAA # to be assigned]

## 4.4 Qualification Test Requirements

### 4.4.1 Test Planning/Procedures

The test and evaluation process will be used to ensure that the contractor has met and implemented the requirements of the Traceability Matrix [this specification FAA # to be assigned]. The contractor will perform the requirement verification in accordance with the contract SOW.

### 4.4.2 Test Phases and Levels

The GBT test efforts will consist of four distinct test phases:

a. Contractor-conducted Factory Acceptance Test (FAT).

b. Government/Contractor - conducted Operational Test (OT).

c. Contractor-conducted Production Acceptance Test (PAT).

d. Government - conducted Independent Operational Test & Evaluation (IOT&E).

## 4.5 Qualification/Verification Methods

The GBT will undergo test and evaluation to verify that the GBT meets specification requirements. The verification methods noted below will be mandatory for GBT requirement verification.

### 4.5.1 Inspection

Inspection of GBT will include verifying physical characteristics to determine compliance with requirements without the use of special laboratory equipment, procedures, items or services. Inspection will verify workmanship, physical condition, construction features, and document/drawing compliance. All tests are non-destructive, static-state examinations of the hardware, the technical data and documentation.

### 4.5.2 Test

The GBT testing will measure hardware performance during or after the controlled application of functional stimuli. Measurements require the use of laboratory equipment, procedures, items, and/or services. Quantitative measurements are analyzed to determine the degree of compliance.

### 4.5.3 Demonstration

Demonstration verification method is used to indicate a general “pass/fail” condition. The items being verified are observed but not quantitatively measured in a dynamic state. This method may use technical data and documentation to determine the qualitative properties of the item being tested. This method does not require special test equipment or instruction to vary characteristics such as operational performance, human engineering features, and service, access features, or transportability.

### 4.5.4 Analysis

The GBT analysis will encompass any or all of the following:

a. Engineering analysis is usually an engineering design function involving study, calculations, or modeling of the known or potential failure modes, and reaction or interactions of the specified parts, materials, and the design configuration with the known function, performance and/or probable effects of the operational environments. This analysis is normally used to verify margin when it is not desirable to test to failure.

b. Similarity analysis is a method applied to end items or components that are identical in design and manufacturing processes to end items or components that have been previously qualified to equivalent or more stringent requirements.

c. Validation of records analysis is a method of verification wherein manufacturing records are used to verify compliance of concealed construction features or processes of manufacturing (e.g. vendor items).

## 5.0 DEFINITIONS

### 5.1 Notes on Information Items

The contents of this Section are for informational purposes only and are not a part of the requirements of this specification. They are not contract requirements nor binding on either the Government or the Contractor. In order for these terms to become a part of the resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the Contractor on the information in these Subsections is wholly at the Contractor's own risk.

### 5.2 Applicable Definitions

#### 5.2.1 Mean Time Between Failures (MTBF)

A basic measure of reliability for LRUs is the sum of the operating time for the failed LRUs divided by the number of failures.

#### 5.2.2 Mean Time To Repair (MTTR)

A basic measure of maintainability: the sum of corrective maintenance times at any specific level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions.

#### 5.2.3 Mean Time To Repair Maximum

The maximum time taken to repair a unit, at a depot level workstation, to return it to an operational state.

### 5.2.4 Duty Cycle

Duty cycle is defined as the percentage of time that the transmitter is keyed in proportion to total service time.

### 5.2.5 Line Replaceable Unit (LRU)

An item which may consist of a unit, an assembly (circuit card assembly, electronic component assembly, etc.), a subassembly, or a part, that is removed and replaced at the site maintenance level in order to restore the system/equipment to operational status.

### 5.2.6 Initialization

Initialization (also cold start) occurs when (a) the GBT equipment is first turned on when delivered from the factory, and (b) when the GBT receives the Reset command with Value of Factory Reset. A result of initialization is that all control parameters return to their default values.

### 5.2.7 Restoral

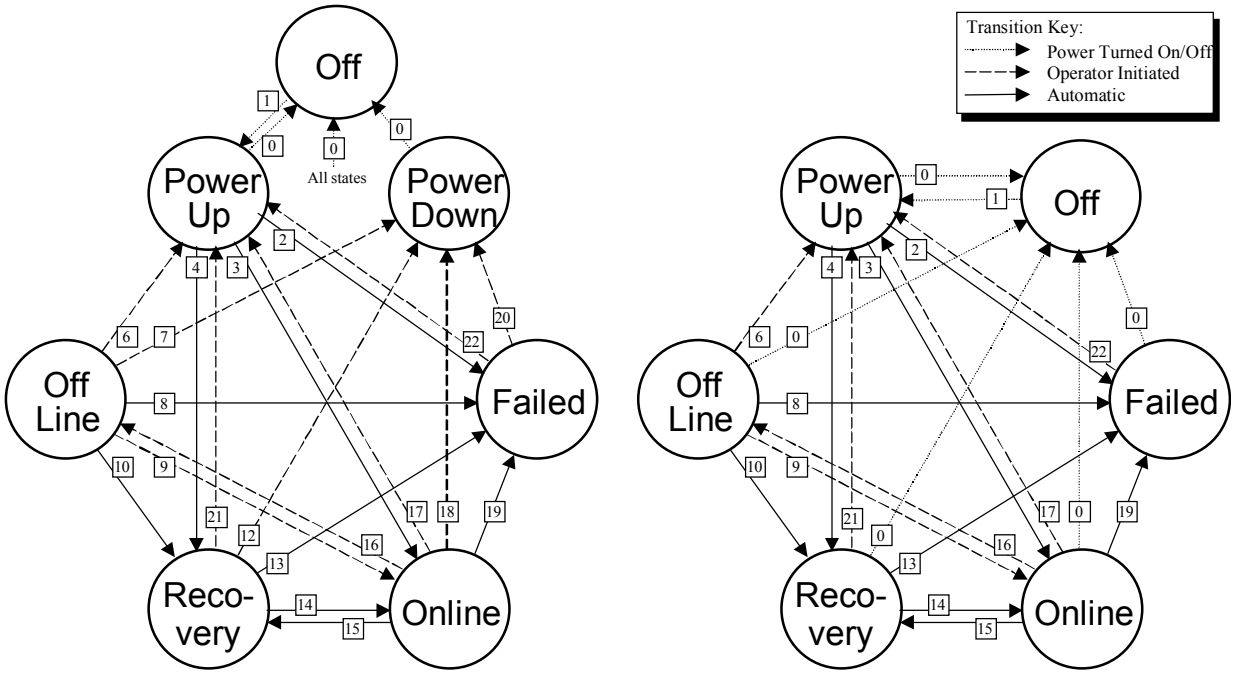
Restoral (also warm start) occurs when the power is returned to the GBT equipment under all conditions other than initialization. As a result of restoral function all configuration items are automatically restored to the values that were in effect in the operational state before the restoral stimulus occurs.

### 5.2.8 GBT State Definitions

- OFF GBT does not receive power sufficient for GBT operation.
- POWER UP The state the GBT is in during the time between power restoral, power turn on or Operator commanded Reset, and the GBT is:
- entering Online or Offline, or
- entering Failed state after detecting a non-recoverable failure, or
- entering Failed state after detecting that the GBT was in Failed state immediately prior to most recent power down or power loss, or
- entering Recovery state after detecting a potentially recoverable failure. The GBT will conduct initial self testing (e.g. BIT or POST) during the Power Up state.
- OFFLINE The non-operational state the GBT assumes during a Control Session invoked by the maintenance technician. The GBT will conduct background built-in testing to verify GBT health.
- ONLINE The operational state in which the GBT meets all operational requirements and all functions are enabled except most control commands. The GBT will conduct background built-in testing to verify GBT health.
- RECOVERY A non-operational state entered after the GBT detects a potentially recoverable error, in which only certain monitor and control functions are enabled.
- FAILED The non-operational state the GBT enters after a non-recoverable failure has been detected or the Recovery process has failed. During Failed state, only those monitor and control functions that can be performed accurately, despite the failure are enabled.

- POWER DOWN The state the GBT enters after an Operator-commanded Shutdown, but before the power is removed. All GBT functions, except those required to complete the Power Down process, are disabled.

*Note: This is an optional state that a vendor's implementation may require. If the vendor's implementation includes a power down sequence other than removing power (i.e. that takes any time), the Power Down state requirements apply.*




Power Down State present

No Power Down State

**Figure 5-1 GBT State Diagram**

**Table 5-1 State Transition Table**

| Transition | From State | To State | Auto/Manual | Description (Condition for Transition) |
|---|---|---|---|---|
| 0 | Any | Off | M/(A) | Whenever power is turned off or when power down state is lost. |
| 1 | Off | Power Up | M/(A) | Whenever power is turned on (or restored) |
| 2 | Power Up | Failed | A | When Power Up sequence fails or Failed State entered before last Power Down/Off |
| 3 | Power Up | Online | A | a) successful completion of Power Up sequence, and<br>b) State before Power Down/Off was Offline |
| 4 | Power Up | Recovery | A | Power Up sequence completed but recoverable error detected |
| 5 (reserved) | | | | |
| 6 | Offline | Power Up | M | Operator commanded Reset |
| 7 | Offline | Power Down | M | Local operator initiates power-down |
| 8 | Offline | Failed | A | GBT detects unrecoverable error (e.g., POST, BIT, etc.) |
| 9 | Offline | Online | M | Control session termination |
| 10 | Offline | Recovery | A | Potentially recoverable error detected while Offline |
| 11 (reserved) | | | | |
| 12 | Recovery | Power Down | M | Local Operator initiates power down |
| 13 | Recovery | Failed | A | Recovery sequence unsuccessful |
| 14 | Recovery | Online | A | a) Recovery sequence successful and<br>b) Previous state was Online |
| 15 | Online | Recovery | A | Potentially recoverable error detected while Online |
| 16 | Online | Offline | M | Maintenance technician initiates Control Session via maintenance interface |
| 17 | Online | Power Up | M | Operator commanded Reset |
| 18 | Online | Power Down | M | Local Operator initiates power-down |
| 19 | Online | Failed | A | GBT detects unrecoverable error (e.g., POST, BIT, etc.) |
| 20 | Failed | Power Down | M | Local Operator initiates power-down |
| 21 | Recovery | Power Up | M | Operator commanded Reset |
| 22 | Failed | Power Up | M | Operator commanded Reset |

#### 5.2.8.1 Non-Volatile Memory

The GBT memory storage will retain data for the life of the equipment.

### 5.2.9 Equipment Failures

Equipment failure is classified into non-critical failure and critical failure.

#### 5.2.9.1 Non-critical Equipment Failure

Non-critical equipment failures are failures of the GBT that will not affect the operations of the GBT, e.g., front panel display and power indicator failures.

#### 5.2.9.2 Critical Equipment Failure

Critical equipment failures are failures of the GBT that will either disrupt the operational traffic flow or that will result in loss of capabilities and functions required for continued safe operation of the GBT. Examples of the former include failure to the power amplifier in the transmitter, failure to the RF front end in the receiver, and failure to the power supply subsystem of the GBT. Examples of the latter include failures of the control or monitoring capabilities in the MMC system.

### 5.2.10 GBT RF Output

The transmitter connector to which the antenna would be connected in a particular configuration.

### 5.2.11 GBT RF Input

The receiver connector to which the antenna would be connected in a particular configuration.

### 5.2.12 Message

A broadcast transmission containing a payload of user information and overhead coding that supports the transfer of data.

## 6.0 ACRONYMS

| | |
|---|---|
| A/G | Air-Ground |
| AC | Alternating Current |
| ACAC | Area Command Aviation Coordinator |
| ACK | Acknowledgment |
| ADS-B | Automatic Dependent Surveillance, Broadcast |
| AF | Airway Facilities |
| AGC | Automatic Gain Control |
| AM | Amplitude Modulation |
| AM®S | Aeronautical Mobile (Route) Services |
| AMP | Ampere(s) |
| ANSI | American National Standards Institute |
| APDU | Application Protocol Data Unit |
| ARTCC | Air Route Traffic Control Center |
| ASTERIX | All Purpose Structured Eurocontrol suRveillance Information Exchange |
| ASTM | American Society of Testing and Materials |
| ATC | Air Traffic Control |
| ATCRBS | ATC Radar Beacon System |
| ATM | Air Traffic Management |
| ATN | Aeronautical Telecommunications Network |
| BER | Bit Error Rate |
| BIT | Built in Test |
| BSDU | Broadcast Services Data Unit |
| C | Centigrade |
| CAT | Category |
| CDTI | Cockpit Display of Traffic Information |
| CFIT | Controlled Flight into Terrain |
| CFR | Code of Federal Regulations |
| CNS | Communications, Navigation, and Surveillance |
| COTS | Commercial Off The Shelf |
| CRC | Cyclic Redundancy Check |
| CW | Continuous Wave |
| D-burst | Data Burst |
| D8PSK | Differential 8 Phase Shift Keying |
| dB | Decibel |
| dBc | Decibels referenced to carrier |
| dBi | Decibels referenced to isotropic |
| dBm | Decibels referenced to 1 milliwatt |
| DC | Direct Current |
| DLS | Data Link Service |
| DME | Distance Measuring Equipment |
| DOT | Department of Transportation |
| DSB-AM | Double Side-Band Amplitude Modulation |
| DSRCE | Down Scoped Radio Control Equipment |
| EIA | Electronic Industries Alliance |
| EMC | Electromagnetic Compatibility |
| EPU | Estimated Position Uncertainty |
| ERP | Effective Radiated Power |
| ESD | Electrostatic Discharge |
| ETSI | European Telecommunications standards Institute |
| EVM | Error Vector Magnitude |
| FAA | Federal Aviation Administration |

| | |
|---|---|
| FCC | Federal Communications Commission |
| FEC | Forward Error Correction |
| FIR | Finite Duration Impedance Response (filter) |
| FIS-B | Flight Information Services, Broadcast |
| FM | Frequency Modulation |
| FRN | Field Reference Number [ASTERIX] |
| Freq | Frequency |
| FSPEC | Field Specification [ASTERIX] |
| FX | Field Extension Indicator [ASTERIX] |
| GBT | Ground Based Transceiver |
| GME | Global Management Entity |
| GNI | Ground Network Interface |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| HAE | Height Above ellipsoid |
| Hz | Hertz |
| HD | Header |
| HDLC | High Level Data Link Control |
| HFOM | Horizontal Figure of Merit |
| HPL | Horizontal Protection Limit |
| ICAO | International Civil Aviation Organization |
| ICD | Interface Control Document |
| ID | Identification |
| IEC | International Engineering Consortium |
| IEEE | Institute of Electrical and Electronic Engineers |
| IP | Internet Protocol |
| ISO | International Standards Organization |
| Kbps | Kilo Bytes Per Second |
| kHz | kilohertz |
| km | kilometer |
| LAAS | Local Area Augmentation System |
| LAN | Local Area Network |
| LBAC | Logical Burst Access Channel |
| LED | Light Emitting Diodes |
| LEN | Length |
| LRU | Line Replaceable Unit |
| LSB | Least Significant Bit |
| M | Meter |
| mA | milliampere |
| MAC | Media Access Control |
| MASPS | Minimum Aviation System Performance Standards |
| Mbps | Mega-Bytes Per second |
| MDT | Maintenance Data Terminal |
| MEARTS | Micro-Enroute Automated Radar Tracking System |
| METAR | Meteorological Aviation Report |
| MHz | Megahertz |
| MMC | Maintenance Management Center |
| MOPS | Minimum Operational Performance Standards |
| ms | milliseconds |
| MSB | Most Significant Bit |
| MSO | Message Start Opportunity |
| MTBF | Mean Time Between Failures |
| MTTR | Mean Time To Repair |
| N/A | Not Applicable |

| | |
|---|---|
| NACp | Navigation Accuracy Category for Position |
| NACv | Navigation Accuracy Category for Velocity |
| NAS | National Airspace System |
| NEMA | National Electrical Manufacturers Association |
| NEXRAD | Next Generation Weather Radar |
| NFPA | National Fire Protection Association |
| NIC | Navigation Integrity Category |
| NIMS | NAS Infrastructure Management System |
| NIST | National Institute of Standards and Technology |
| NOTAM | Notice To Airmen |
| nm | nautical mile |
| nsec | nanosecond |
| NTIA | National Telecommunications and Information Administration |
| OEM | Original Equipment Manufacturer |
| OSI | Open System Interconnection |
| PC | Personal Computer |
| PCB | Printed Circuit Board |
| PCM | Pulse Code Modulation |
| POST | Power-up Operational Self Test |
| PPM | parts per million |
| PPS | Pulse(s) Per Second |
| PWR | Power |
| RAM | Random Access Memory |
| RCAG | Remote Center Air/Ground |
| RCE | Remote Control Equipment |
| RCO | Remote Communications Outlet |
| RD | Ramp-down |
| Ref | Reference |
| RF | Radio Frequency |
| RIU | Remote Interface Unit |
| RMM | Remote Maintenance Monitoring |
| RMMC | Remote Maintenance Monitoring Control |
| RMS | Remote Monitoring Subsystem |
| RNP | Required Navigational Performance |
| RTCA | RTCA, Inc. (formerly Radio Technical Commission for Aeronautics) |
| RTN | Return to Normal |
| RTR | Remote Transmitter Receiver |
| RU | Ramp-up and Power Stabilization |
| Rx | Receiver |
| SA | Selective Availability |
| SAC | System Area Code |
| SDU | Session Layer Data Unit |
| SIC | System Identification Code |
| SIL | Surveillance Integrity Level |
| SINAD | Ratio of Signal plus Noise plus Distortion to Noise plus Distortion |
| SMR | Successful Message Reception |
| SNAcP | Sub-Network Access Protocol |
| SOC | System Operations Centers |
| SRD | System Requirements Document |
| SRS | Software Requirements Document |
| SSR | Secondary Surveillance Radar |
| SSS | Sub-System Specification |
| SUA | Special User Airspace |
| TACAN | Tactical Air Navigation |

| | |
|---|---|
| TBD | To Be Determined |
| TBS | To Be Selected |
| TCAS | Traffic Alert and Collision Avoidance System |
| TCP | Transmission Control Protocol |
| TCS | Tower Communications System |
| TDMA | Time Division Multiple Access |
| TAF | Terminal Area Forecast |
| TFOM | Time Figure of Merit |
| THD | Total Harmonic Distortion |
| TIS-B | Traffic Information Services, Broadcast |
| TOA | Time of Arrival |
| TOMR | Time Of Message Receipt |
| TOT | Time of Transmission |
| TRP | Timing Reference Point |
| TTL | Transistor-transistor logic |
| Tx | Transmitter |
| UAP | User Application Profile |
| UAT | Universal Access Transceiver |
| UDP | User Datagram Protocol |
| UHF | Ultra High Frequency |
| UTC | Universal Coordinated Time |
| VA | Volt Ampere |
| VAC | Volts Alternating Current |
| VDC | Volts Direct Current |
| VDL | VHF Digital Link |
| VFOM | Vertical Figure of Merit |
| VHF | Very High Frequency |
| V | Volt |
| VPL | Vertical Protection Limit |
| VRTM | Verification Requirements Traceability Matrix |
| VSWR | Voltage Standing Wave Ratio |
| W | Watt |
| WAAS | Wide Area Augmentation System |

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

**A.1 General**

The format for target reports is based on the ASTERIX message standard adopted by Eurocontrol for surveillance data exchange. For background information on the ASTERIX structure and encoding see the document entitled, "Eurocontrol Standard Document for Surveillance Data Exchange, Part 1, ASTERIX," SUR.ET1.ST05.2000-STD-01-01, November 1997. This document is available at http://www.eurocontrol.be/projects/eatchip/asterix.

A User Application Profile (UAP) is a mechanism for assigning Data Item to Data Fields of ASTERIX messages and containing all necessary information which needs to be standardized for the successful encoding and decoding of the messages. An ASTERIX Data Category (CAT) is defined by a set of Data Items that could be included in valid messages of that category. The ASTERIX Data Category for Target Reports To/From the GBT has been given the assignment "033"[6]. This value, which is normally the first Data Item in a Data Block, is also interpreted to be the BSDU ID field (Section 3.2).

The Field Reference Number (FRN) establishes the order of the items in the FSPEC, and along with the Category code serves to uniquely identify each data item. In order to maximize compatibility with future versions of this category, these data items will retain the same FRN and order in the FSPEC while new items may be added onto the end of the FSPEC.

[6] This category number is being established for use within the NAS; this category definition has not been approved by Eurocontrol

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## A.2 Target Report Construction Example

**Time** ⟶

| FSPEC | FRN 1 Version Number | FRN 2 Data Source ID | FRN 3 Data Link Indicator | FRN 4 Time of Applicability | FRN 5 Target Addreess | FRN 6 Integrity and Accuracy Params | FRN 7 Latitude/Longitude | FRN 8 Pressure Altitude | FRN 10 Velocity (Surface) |
|---|---|---|---|---|---|---|---|---|---|

| F1 | F2 | F3 | F4 | F5 | F6 | F7 | FX | F8 | F9 | F10 | F11 | F12 | F13 | F14 | FX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

1. *Within each Data Item, Byte 1 is transmitted first*
2. *"FX" is the Field Extension bit. A ONE in this bit indicates the field extends into the next byte.*

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

### A.3 User Application Profile and Construction for Cat 033 Target Reports

Table A-1. Cat 033 (V 1) User Application Profile and Construction

| FRN | Data Item | Length in Bytes (when present) |
|---|---|---|
| 1 | Version Number | 1 |
| 2 | Data Source Identifier | 2 |
| 3 | Link Technology Indicator | 1 |
| 4 | Time of Applicability | 3 |
| 5 | Target Address | 4 |
| 6 | Integrity and Accuracy Parameters | 2 |
| 7 | Latitude/Longitude | 6 |
| 8 | Pressure Altitude | 2 |
| 9 | Velocity (Airborne) | 5 |
| 10 | Velocity (Surface) | 3 |
| 11 | Mode 3/A Code | 2 |
| 12 | Target Identification | 6 |
| 13 | Emitter Category | 1 |
| 14 | Target Status | 1 |
| 15 | Geometric Altitude | 2 |
| 16 | *Reserved for Future Definition* | N/A |
| 17 | Time of Message Transmission | 4 |
| 18 | Time of Message Reception | 4 |
| 19 | *Reserved for Future Definition* | N/A |
| 20 | *Reserved for Future Definition* | N/A |
| 21 | *Reserved for Future Definition* | N/A |
| 22 | *Reserved for Future Definition* | N/A |

Note: Systems receiving Cat 033 reports must parse the FSPEC for proper decoding since some Data Items are optional in any given report.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## A.4 Format and Encoding of Cat 033 (V 1.0) Data Items

### FRN 1: Version Number

Definition: Version of this Cat 033 format**.**
Structure: One byte fixed length data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Spare bit | Spare bit | Version Status | Msb — Version Number — Lsb | | | | |

Encoding:

| | |
|---|---|
| Bits 8/7: | Spare bits set to ZERO |
| Bit 6: | ZERO=Version for operational use; ONE=Version is for experimental use only |
| Bits 5/1: | Cat 033 version number encoded as binary numeral in the range of 1 to 31 (Value of ZERO represents "unknown" version regardless of "Version Status". |

Category 33 messages conforming to this document shall be encoded with the value ONE in the Version Number field (Bits 5/1).

Notes:

1. This provides an upgrade path for evolution of this Category without incrementing the Category number modulo 32.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 2: Data Source Identifier

Definition: Identification of the system supplying surveillance data**.**
Structure: Two byte fixed length data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Msb | | | | | | | Lsb | Msb | | | | | | | Lsb |
| --SAC-- | | | | | | | | --SIC-- | | | | | | | |

Encoding:

bits 16/9: (SAC)System Area Code (0 → 255)
bits 8/1: (SIC)System Identification Code (0 → 255)

Notes:

1. The SAC is used to identify regions of the world.
2. The SIC is used to identify individual systems (e.g., ADS-B receiver or TIS-B transmitter, radar/beacon sensor, multisensor fusion processor, etc)

# APPENDIX A TO GBT SYSTEM SPECIFICATION
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## FRN 3: Link Technology Indicator

Definition: Used to specify the data link or link(s) to which the Target Report is applicable.
Structure: One byte fixed length data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Spare bit | Link Version # | | | 1090 ES | UAT | VDL4 | Other |

Encoding:

| | |
|---|---|
| Bit 8 | spare bit set to ZERO |
| Bits7/5 | version # from link MOPS, binary encoded. Bit 7 is MSB and Bit 5 is LSB. |
| Bit 4 | 1090 ES (ZERO=not used, ONE=used) |
| Bit 3 | UAT (ZERO=not used, ONE=used) |
| Bit 2 | VDL4 (ZERO=not used, ONE=used) |
| Bit 1 | Other data link (ZERO=not used, ONE=used) |

Notes**:**

The information conveyed in this data item supports the case where a multilink-capable transceiver is operating with a single SAC/SIC code allocation.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
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## FRN 4: Time Of Applicability

Definition: Time at which the target position is expected to be an accurate estimate of the true target state vector.

Structure: Three byte fixed data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| Msb | --Time of Applicability-- | | | | | | |

| Byte 2 | | | | | | | | Byte 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Time of Applicability-- | | | | | | | | | | | | | | | Lsb |

Encoding:

Bits 24/8 whole seconds elapsed since UTC midnight binary encoded

Bits 7/1 fractional seconds elapsed since UTC midnight binary encoded

**Notes:**

1. The time of the day value is reset to 0 at every midnight. The time of the day is specified in UTC.
2. The Lsb represents 1/128 of a second

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 5: Target Address

Definition: Identifies a target through a 24 bit address associated with the target plus 4 bits of address qualifier

Structure: Four byte fixed length data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| Spare bits | | | | | Address Qualifier | | | Msb --24 bit Address-- | | | | | | | |
| Byte 3 | | | | | | | | Byte 4 | | | | | | | |
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --24-bit Address-- | | | | | | | | | | | | | | | Lsb |

**Encoding:**

Bits 32/28: spare bits always set to ZERO

Bits 27/25:

ADDRESS QUALIFIER

| ***Address Qualifier (binary)*** | | | | ***Address Type*** |
|---|---|---|---|---|
| *Bit 27* | *Bit 26* | *Bit 25* | | |
| *0* | *0* | *0* | | *ADS-B target with ICAO 24-bit address* |
| *0* | *0* | *1* | | *ADS-B target with self-assigned temporary address* |
| *0* | *1* | *0* | | *TIS-B target with ICAO 24-bit address* |
| *0* | *1* | *1* | | *TIS-B target with track file identifier* |
| *1* | *0* | *0* | | *Surface Vehicle* |
| *1* | *0* | *1* | | *Fixed Beacon* |
| *1* | *1* | *0* | | *(Reserved)* |
| *1* | *1* | *1* | | *(Reserved)* |

Bits 24/1: 24 bit Address

# APPENDIX A TO GBT SYSTEM SPECIFICATION
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## FRN 6: Integrity and Accuracy Parameters (Page 1 of 3)

Definition: This data item conveys the accuracy and integrity parameters reported by the ADS-B target
Structure: Two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| UTC | Msb --NIC-- Lsb | | | | --SIL-- | | | Msb --NACp-- Lsb | | | | | Pos Est | Vel Est | Spare bit |

Encoding:

Bit 16: ONE = ADS-B message payload indicates the "UTC coupled" condition
ZERO = ADS-B message payload indicates the "non-UTC coupled" condition

Bits 15/12: Navigation Integrity Categories (NIC)

The Navigation Integrity Category (NIC) is reported so that surveillance applications may determine whether the reported position has an acceptable level of integrity for the intended use. The value of the NIC parameter specifies an integrity containment radius, $R_C$..

| **NIC bits** Msb Lsb | **Horizontal and Vertical Containment Bounds** | **Comment** |
|---|---|---|
| 0000 | $R_C \geq 37.04$ km (20 NM) | Unknown Integrity |
| 0001 | $R_C < 37.04$ km (20 NM) | RNP-10 containment radius |
| 0010 | $R_C < 14.816$ km (8 NM) | RNP-4 containment radius |
| 0011 | $R_C < 7.408$ km (4 NM) | RNP-2 containment radius |
| 0100 | $R_C < 3.704$ km (2 NM) | RNP-1 containment radius |
| 0101 | $R_C < 1852$ m (1 NM) | RNP-0.5 containment radius |
| 0110 | $R_C < 1111.2$ m (0.6 NM) | RNP-0.3 containment radius |
| 0111 | $R_C < 370.4$ m (0.2 NM) | RNP-0.1 containment radius |
| 1000 | $R_C < 185.2$ m (0.1 NM) | RNP-0.05 containment radius |
| 1001 | $R_C < 75$ m and VPL < 112m | e.g., WAAS HPL, VPL |
| 1010 | $R_C < 25$ m and VPL < 37.5m | e.g., WAAS HPL, VPL |
| 1011 | $R_C < 7.5$ m and VPL < 11m | e.g., LAAS HPL, VPL |

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 6: Integrity and Accuracy Parameters (Page 2 of 3)

Bits 11/9: Surveillance Integrity Levels (SIL)

The value of the SIL parameter specifies the probability of the true position lying outside the NIC-specified containment radius, $R_C$, without alerting, including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used. SIL is a static (unchanging) value that depends on the position sensor being used on the aircraft.

| **SIL Bits** | | | **Probability of Unknowingly Exceeding the $R_C$ Integrity Containment Radius** |
|---|---|---|---|
| Bit 11 | Bit 10 | Bit 9 | |
| 0 | x | x | SIL Not Available in this Reporting Interval |
| 1 | 0 | 0 | SIL Reported as Unknown |
| 1 | 0 | 1 | $1 \times 10^{-3}$ per flight hour or per operation |
| 1 | 1 | 0 | $1 \times 10^{-5}$ per flight hour or per operation |
| 1 | 1 | 1 | $1 \times 10^{-7}$ per flight hour or per operation |

Bits 8/4: Navigation Accuracy Categories for Position (NACp)

The Navigation Accuracy Category for Position (NACp) is reported so that surveillance applications may determine whether the reported position has an acceptable level of accuracy for the intended use. The Estimated Position Uncertainty (EPU) is a 95% accuracy bound on horizontal position. EPU is defined as the radius of a circle, centered on the reported position, such that the probability of the actual position being outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure of Merit). Likewise, Vertical Estimated Position Uncertainty (VEPU) is a 95% accuracy limit on the vertical position. VEPU is defined as a vertical position limit, such that the probability of the actual vertical position differing from the reported vertical position by more than that limit is 0.05. When reported by a GPS or GNSS system, VEPU is commonly called VFOM (Vertical Figure of Merit).

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 6: Integrity and Accuracy Parameters (Page 3 of 3)

| NACp Bits | | 95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU) | Comment |
|---|---|---|---|
| Bit 8 | Bits 7-4 Msb Lsb | | |
| 0 | xxxx | NACp not available in this reporting interval | |
| 1 | 0000 | EPU ≥ 18.52 km (10 NM) | |
| 1 | 0001 | EPU < 18.52 km (10 NM) | RNP-10 accuracy |
| 1 | 0010 | EPU < 7.408 km (4 NM) | RNP-4 accuracy |
| 1 | 0011 | EPU < 3.704 km (2 NM) | RNP-2 accuracy |
| 1 | 0100 | EPU < 1852 m (1NM) | RNP-1 accuracy |
| 1 | 0101 | EPU < 926 m (0.5 NM) | RNP-0.5 accuracy |
| 1 | 0110 | EPU <555.6 m ( 0.3 NM) | RNP-0.3 accuracy |
| 1 | 0111 | EPU < 185.2 m (0.1 NM) | RNP-0.1 accuracy |
| 1 | 1000 | EPU <92.6 m (0.05 NM) | e.g., GPS (with SA) |
| 1 | 1001 | EPU < 30 m and VEPU < 45 m | e.g., GPS (SA off) |
| 1 | 1010 | EPU < 10 m and VEPU < 15 m | e.g., WAAS |
| 1 | 1011 | EPU < 3 m and VEPU < 4 m | e.g., LAAS |

Bit 3: Position Estimated: Set to ZERO when position reported is measured data; set to ONE when position data reported is estimated data.

Bit 2: Velocity Estimated: Set to ZERO when velocity reported is measured data; set to ONE when velocity reported is estimated data.

Bit 1 Spare bit always be set to ZERO

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 7: Latitude and Longitude (page 1 of 2)

Definition: Target latitude and longitude position.
Structure: Fixed 6 byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 |
| Msb | --Latitude-- | | | | | | | | | | | | | | |
| Byte 3 | | | | | | | | Byte 4 | | | | | | | |
| 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| --Latitude-- | | | | | | | Lsb | Msb | --Longitude-- | | | | | | |
| Byte 5 | | | | | | | | Byte 6 | | | | | | | |
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Longitude-- | | | | | | | | | | | | | | | Lsb |

Encoding:

Bits 48/1: Latitude and Longitude

LATITUDE AND LONGITUDE

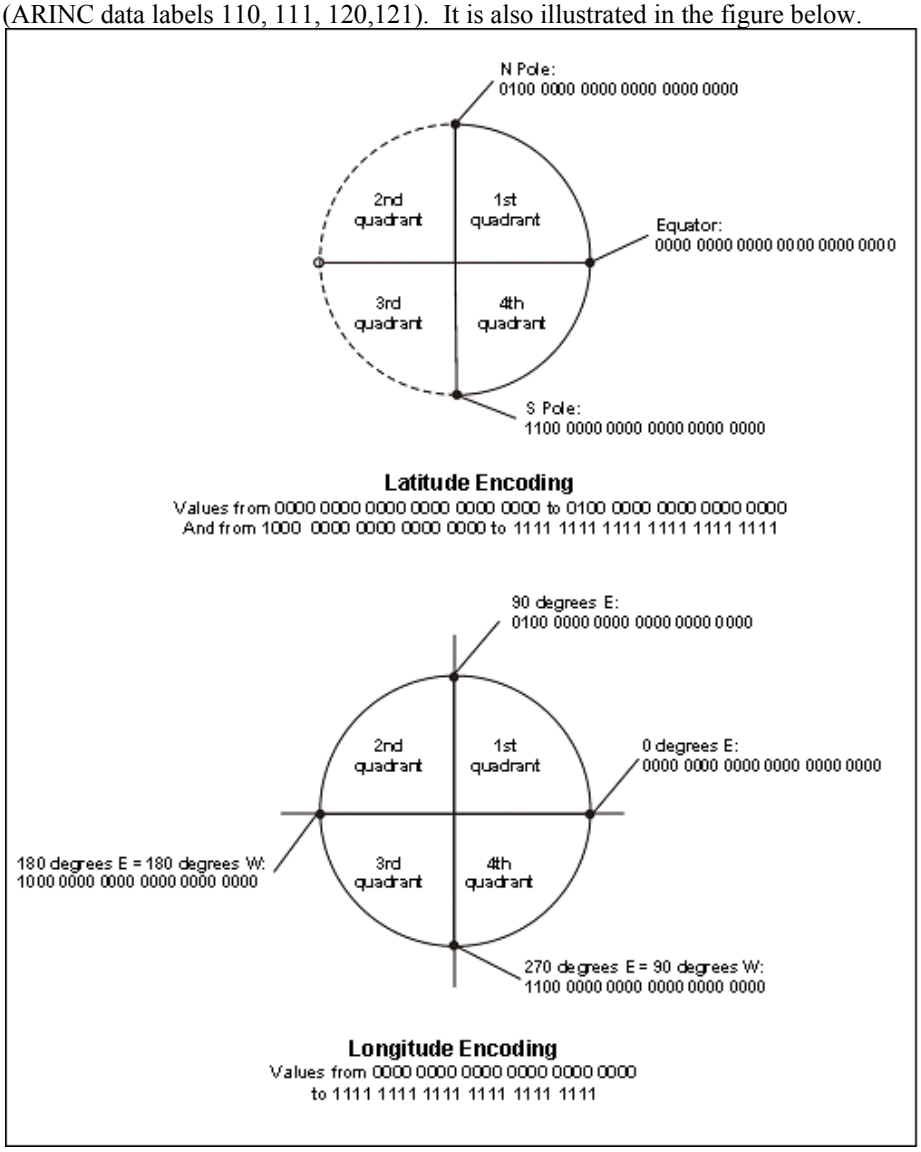
| **Quadrant** | **Latitude or Longitude bits** | **Meaning** $INCR = Lsb = \frac{360}{2^{24}} = 0.00002146\ ^\circ$ | |
|---|---|---|---|
| | Msb Lsb | **Latitude** | **Longitude** |
| 1st quadrant | 0000 0000 0000 0000 0000 0000 | ZERO degrees (Equator) | ZERO degrees (Prime Meridian) |
| | 0000 0000 0000 0000 0000 0001 | *INCR* degrees North | *INCR* degrees East |
| | … | … | … |
| | 0011 1111 1111 1111 1111 1111 | (90-*INCR*) degrees North | (90-*INCR*) degrees East |
| 2nd quadrant | 0100 0000 0000 0000 0000 0000 | 90 degrees (North Pole) | 90 degrees East |
| | 0100 0000 0000 0000 0000 0001 | <Illegal Values> | (90+*INCR*) degrees East |
| | … | <Illegal Values> | … |
| | 0111 1111 1111 1111 1111 1111 | <Illegal Value> | (180-*INCR*) degrees East |
| 3rd quadrant | 1000 0000 0000 0000 0000 0000 | <Illegal Value> | 180 degrees East or West |
| | 1000 0000 0000 0000 0000 0001 | <Illegal Value> | (180-*INCR*) degrees West |
| | … | <Illegal Values> | … |
| | 1011 1111 1111 1111 1111 1111 | <Illegal Values> | (90-INCR) degrees West |
| 4th quadrant | 1100 0000 0000 0000 0000 0000 | -90 degrees (South Pole) | 90 degrees West |
| | 1100 0000 0000 0000 0000 0001 | (90-*INCR*) degrees Sourth | (90-*INCR*) degrees West |
| | … | … | … |
| | 1111 1111 1111 1111 1111 1111 | *INCR* degrees South | *INCR* degrees West |

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 7: Latitude and Longitude (page 2 of 2)

Notes:

1. This encoding is consistent with that of GPS/GNSS avionics providing Latitude/Longitude inputs to ADS-B (ARINC data labels 110, 111, 120,121). It is also illustrated in the figure below.



# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 8: Pressure Altitude

Definition: Barometric Aircraft altitude referenced to standard atmospheric pressure of 29.92
Structure: Fixed two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| RES | Spare | Msb | | | | | | | | | | | | | Lsb |
| | | --Pressure Altitude-- | | | | | | | | | | | | | |

Encoding:

Bit 16 Resolution of altitude encoding (ZERO=100 feet; ONE=25 feet)
Bit 15 Spare bit always set to ZERO
Bits14/1 Binary 2's compliment encoding of altitude with 25' Lsb

PRESSURE ALTITUDE

| **Pressure Altitude bits** Msb Lsb | **Meaning** |
|---|---|
| 10 0000 0000 0000 | No pressure altitude information available |
| 10 0000 0000 0001 | -204775 feet |
| 10 0000 0000 0010 | -204750 feet |
| *** | |
| 11 1111 1111 1110 | -50 feet |
| 11 1111 1111 1111 | -25 feet |
| 00 0000 0000 0000 | ZERO feet |
| 00 0000 0000 0001 | 25 feet |
| 00 0000 0000 0010 | 50 feet |
| *** | |
| 01 1111 1111 1110 | 204750 feet |
| 01 1111 1111 1111 | 204775 feet |

Notes:

Airborne ADS-B transmitters are restricted to a range of values for Pressure Altitude of –1000 feet to + 101, 325 feet.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 9: Velocity (Airborne)(page 1 of 2)

Definition: The Velocity reported by the aircraft indicated by the North/South and East/West Velocity and vertical rate of change.

Structure: Fixed five byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 |
| sb | VV Src | SO | NS | Msb --N/S Velocity-- | | | | | | | | | | | Lsb |

| Byte 3 | | | | | | | | Byte 4 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 |
| EW | Msb --E/W Velocity-- | | | | | | | | | | | Lsb | U D | Msb | |

| Byte 5 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Vertical Rate-- | | | | | | | Lsb |

Encoding:

Bit 40 Spare bit, always set to ZERO

Bit 39 VV Src: Indicates the source of vertical velocity (ZERO=Baro; ONE=GNSS)

Bit 38 SO: Indicates the scale factor to be used for N/S and E/W velocities (ZERO=Subsonic--0.25 kt Lsb; ONE=Supersonic—2 kt Lsb)

Bit 37 NS Indicates the direction of the N/S velocity (ZERO=North; ONE=South).

Bits 36/25 N/S Velocity (Ground Referenced)

NORTH/SOUTH VELOCITY (Ground Referenced)

| **N/S Velocity bits** Msb Lsb | **Meaning (when "SO"=ZERO)** (N/S Velocity in knots) | **Meaning (when "SO"=ONE)** (N/S Velocity in knots) |
|---|---|---|
| 000 0000 0000 | No Information available | |
| 000 0000 0001 | ZERO | |
| 000 0000 0010 | 0.25 | 2 |
| 000 0000 0011 | 0.5 | 4 |
| *** | *** | *** |
| 111 1111 1110 | 1023.5 | 8188 |
| 111 1111 1111 | > 1023.5 | > 8188 |

The encoding shown in the table represents Positive Magnitude data only. Direction is given completely by the North/South Direction Bit.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 9: Velocity (Airborne) (page 2 of 2)

Bit 24 EW Indicates the direction of the E/W velocity (ZERO=East; ONE=West).

Bits 23/12 E/W Velocity (Ground Referenced)

EAST/WEST VELOCITY (Ground Referenced)

| **E/W Velocity bits** Msb Lsb | **Meaning (when "SO"=ZERO)** (E/W Velocity in knots) | **Meaning (when "SO"=ONE)** (E/W Velocity in knots) |
|---|---|---|
| 000 0000 0000 | No Information Available | |
| 000 0000 0001 | ZERO | |
| 000 0000 0010 | 0.25 | 2 |
| 000 0000 0011 | 0.5 | 4 |
| *** | *** | *** |
| 111 1111 1110 | 1023.5 | 8188 |
| 111 1111 1111 | > 1023.5 | > 8188 |

The encoding shown in the table represents Positive Magnitude data only. Direction is given completely by the East/West Direction Bit.

Bit 11 UD Indicates vertical rate direction (ZERO=Up; ONE=Down).

Bits 10/1 Vertical rate of change with 32 fpm Lsb

VERTICAL RATE

| **Vertical Rate bits** Msb Lsb | **Meaning** (VERTICAL RATE in feet / minute) |
|---|---|
| 00 0000 0000 | No Information Available |
| 00 0000 0001 | ZERO |
| 00 0000 0010 | 32 |
| 00 0000 0011 | 64 |
| *** | *** |
| 11 1111 1110 | 32,704 |
| 11 1111 1111 | 32,736 |

The encoding shown in the table represents Positive Magnitude data only. Direction is given completely by the Vertical Rate Sign Bit.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 10: Velocity (Surface) (page 1 of 2)

Definition: Velocity format reported when target is known to be ON GROUND
Structure: Fixed three byte data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| Trk/Hdg Valid | Trk/Hdg | True/Mag | Msb --Grnd Trk/Hdg-- | | | | |

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Grnd Trk/Hdg-- | | | | Lsb | Msb | | | --Ground Speed-- | | | | | | | Lsb |

Encoding:

Bit 24 Track/Hdg Valid (ZERO = Ground Track/Hdg data is NOT Valid; ONE = Ground Track/Hdg data is Valid

Bit 23 Track/Heading bit (ZERO= Track; ONE=Heading)

Bit 22 True/Magnetic bit (ZERO=True; ONE=Magnetic)

Bits 21/12 Ground Track represented as a binary number

GROUND TRACK/HEADING

| **Grnd Trk/Hdg bits** Msb Lsb | **Meaning** $INCR = Lsb = \frac{360}{2^{10}} = 0.3515625°$ |
|---|---|
| 00 0000 0000 | ZERO degrees |
| 00 0000 0001 | *INCR* degrees |
| *** | |
| 01 1111 1111 | (180-*INCR*) degrees |
| 10 0000 0000 | 180 degrees |
| 10 0000 0001 | (180+*INCR*) degrees |
| *** | |
| 11 1111 1111 | (360-*INCR*) degrees |

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 10: Velocity (Surface) (page 2 of 2)

Bits 11/1 Binary encoding (linear) of Ground Speed with 0.125 kt Lsb

GROUND SPEED

| **Ground Speed bits** Msb Lsb | **Meaning** |
|---|---|
| 000 0000 0000 | Ground Speed Not Available |
| 000 0000 0001 | ZERO |
| 000 0000 0010 | 0.125 kts |
| 000 0000 0011 | 0.250 kts |
| *** | *** |
| 111 1111 1110 | 255.625 kts |
| 111 1111 1111 | 255.750 kts |

Notes:

1. Surface (polar) format is different from airborne format because the ability to discern a track angle from the Airborne (cartesian) format suffers at low speeds. Also use of polar format allows for a heading input if available. Heading (if available) can provide more reliable information on aircraft orientation on the surface when stationary or moving very slowly.
2. Aircraft are allowed to report velocity in this format when it is known for certain they are on the surface. It is also used by surface vehicles.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 11: Mode 3/A Code

Definition: Aircraft's Mode-3/A code as entered into the aircraft's currently active transponder.

Structure: Fixed two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Spare Bit | Spare Bit | Spare Bit | Spare Bit | Msb Mode-3/A Code | | | | | | | | | | | Lsb |

Encoding:

Bits 16/13 Spare.
Bits 12/1 Mode-3/A code.

Notes:

1. Having ADS-B transmit this information has been proposed as a convenient way for existing ATC automation systems to correlate ADS-B targets with their filed flight plans as is currently done with SSR. This data item responds to Alaska Capstone Program desire to add a Mode-A code reporting capability to ADS-B in Alaska. (Provisions for this requirement are under coordination with SC-186/WG6 for possible inclusion in a future version of the ADS-B MASPS.(DO-242A). (See RTCA Paper Number SC-186-WG5/UAT-WP-14-02, dated 24 July 2002, by Mosher, Jennings, Pagano, Furr.) SC186 WG3 is considering whether to add the Mode A code to the 1090 MHz ES system

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 12: Target Identification (page 1 of 2)

Definition: Target Identification (in 8 characters) reported by the aircraft/vehicle. This is generally the radio call sign.

Structure: Six byte fixed length data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 |
| Msb (b6) | | | --Char 1-- | | Lsb (b1) | Msb (b6) | | --Char 2-- | | | Lsb (b1) | Msb (b6) | | --Char 3-- | |
| Byte 3 | | | | | | | | Byte 4 | | | | | | | |
| 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| | Lsb (b1) | Msb (b6) | --Char 4-- | | | | Lsb (b1) | Msb (b6) | --Char 5-- | | | | Lsb (b1) | Msb (b6) | |
| Byte 5 | | | | | | | | Byte 6 | | | | | | | |
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Char 6-- | | | Lsb (b1) | Msb (b6) | --Char 7-- | | | Lsb (b1) | Msb (b6) | --Char 8-- | | | | | Lsb (b1) |

Encoding:

Bits 48/1 Characters 1-8, coded as 6 bits per character

CHARACTER ENCODING

| **Character *N* bits** | | | | b6 | 0 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|
| | | | | b5 | 0 | 1 | 0 | 1 |
| b4 | b3 | b2 | b1 | | | | | |
| 0 | 0 | 0 | 0 | | | P | sp | 0 |
| 0 | 0 | 0 | 1 | | A | Q | | 1 |
| 0 | 0 | 1 | 0 | | B | R | | 2 |
| 0 | 0 | 1 | 1 | | C | S | | 3 |
| 0 | 1 | 0 | 0 | | D | T | | 4 |
| 0 | 1 | 0 | 1 | | E | U | | 5 |
| 0 | 1 | 1 | 0 | | F | V | | 6 |
| 0 | 1 | 1 | 1 | | G | W | | 7 |
| 1 | 0 | 0 | 0 | | H | X | | 8 |
| 1 | 0 | 0 | 1 | | I | Y | | 9 |
| 1 | 0 | 1 | 0 | | J | Z | | |
| 1 | 0 | 1 | 1 | | K | Illegal Values | | |
| 1 | 1 | 0 | 0 | | L | | | |
| 1 | 1 | 0 | 1 | | M | | | |
| 1 | 1 | 1 | 0 | | N | | | |
| 1 | 1 | 1 | 1 | | O | | | |

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 12: Target Identification (page 2 of 2)

Notes:
1. Character 1 is leftmost
2. Characters must be left justified using <space> fill if less than 8 characters are used

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 13: Emitter Category

Definition: The target's category code for the current position report.
Structure: Fixed one byte data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Msb --Category Code-- Lsb | | | | | | sb | |

Encoding:

Bits 8/3 Category Code

CATEGORY CODE

| (decimal) | Category Code bits Msb Lsb | Meaning |
|---|---|---|
| 0 | 00 0000 | No aircraft type information |
| 1 | 00 0001 | Light (< 15 500 lbs) |
| 2 | 00 0010 | Small (15 500 to 75 000 lbs) |
| 3 | 00 0011 | Large (75 000 to 300 000 lbs) |
| 4 | 00 0100 | High Vortex Large |
| 5 | 00 0101 | Heavy (> 300 000 lbs) |
| 6 | 00 0110 | High Performance (> 5G acceleration) |
| 7 | 00 0111 | Rotocraft |
| 8 | 00 1000 | (Unassigned) |
| 9 | 00 1001 | Glider/sailplane |
| 10 | 00 1010 | Lighter than air |
| 11 | 00 1011 | Parachutist/sky diver |
| 12 | 00 1100 | Ultra light/hang glider/paraglider |
| 13 | 00 1101 | (Unassigned) |
| 14 | 00 1110 | Unmanned aerial vehicle |
| 15 | 00 1111 | Space/transatmospheric vehicle |
| 16 | 01 0000 | (Unassigned) |
| 17 | 01 0001 | Surface vehicle—emergency vehicle |
| 18 | 01 0010 | Surface vehicle—service vehicle |
| 19 | 01 0011 | Fixed ground or tethered obstruction |
| 20 | 01 0100 | Cluster Obstacle |
| 21 | 01 0101 | Line Obstacle |
| 22-63 | | (Unassigned) |

Bits 2/1 Spare Bits always set to ZERO

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 14: Target Status

Definition: Status information currently being reported by the target.
Structure: Fixed one byte data item
byte data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Receiving ATC Services | IDENT | Spare bit | Spare bit | Msb Status Code | | | Lsb |

Encoding:

Bit 8 ONE indicates the airspace user is receiving ATC services; ZERO indicates the airspace user is NOT receiving ATC services

Bit 7 ONE indicates the avionics is in the IDENT condition; ZERO indicates the avionics is NOT in the IDENT condition

Bits 6/5 Spare bits always set to ZERO

Bits 4/1 Status Code

STATUS CODES

| Status Code bits (decimal) | Status Code bits Msb Lsb | Meaning |
|---|---|---|
| 0 | 0000 | No emergency/Not reported |
| 1 | 0001 | General emergency |
| 2 | 0010 | Lifeguard/medical emergency |
| 3 | 0011 | Minimum fuel |
| 4 | 0100 | No communications |
| 5 | 0101 | Unlawful interference (hijacking) |
| 6 | 0110 | Downed Aircraft |
| 7-15 | 0111-1111 | (Reserved for future definition |
| | | |
| | | |

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 15: Geometric Altitude

Definition: Aircraft altitude derived from GNSS, INS or ground-based measurement (e.g., Multilateration) represented as Height Above Ellipsoid (HAE)

Structure: Fixed two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Msb | | | | | | | | | | | | | | | Lsb |
| --Geometric Altitude (HAE)-- | | | | | | | | | | | | | | | |

Encoding:

Bits16/1 Binary 2's compliment encoding of altitude with 6.25' Lsb

ALTITUDE (GEOMETRIC)

| **Geometric Altitude bits** Msb Lsb | **Meaning** |
|---|---|
| 1000 0000 0000 0000 | No geometric altitude information available |
| 1000 0000 0000 0001 | -204793.75 feet |
| 1000 0000 0000 0100 | -204775 feet |
| 1000 0000 0000 1000 | -204750 feet |
| *** | |
| 1111 1111 1111 1000 | -50 feet |
| 1111 1111 1111 1100 | -25 feet |
| 1111 1111 1111 1111 | -6.25 feet |
| 0000 0000 0000 0000 | ZERO feet |
| 0000 0000 0000 0001 | 6.25 feet |
| 0000 0000 0000 0100 | 25 feet |
| 0000 0000 0000 1000 | 50 feet |
| *** | |
| 0111 1111 1111 1000 | 204750 feet |
| 0111 1111 1111 1100 | 204775 feet |
| 0111 1111 1111 1111 | 204793.75 feet |

Notes:

1. Encoding consistent with Pressure Altitude item with the exception of two additional bits of precision which appear here.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
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**FRN 16:** ***Reserved for Future Data Item***

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 17: Time of Message Transmission

Definition: The time at which the ADS-B message was transmitted from the aircraft/vehicle expressed as fractional seconds from the UTC second.

Structure: Fixed four byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| Msb --Time of Message Transmission-- | | | | | | | | | | | | | | | |
| Byte 3 | | | | | | | | Byte 4 | | | | | | | |
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Time of Message Transmission-- Lsb | | | | | | | | | | | | | | | |

Encoding:

Bits 32/1 Time of message transmission encoded as nanoseconds elapsed after the UTC 1 second time mark.

TIME OF MESSAGE TRANSMISSION

| **Time of Message Transmission bits** Msb Lsb | **Meaning** $INCR = Lsb = \frac{1 \text{ sec}}{2^{32}} = 0.2328$ nanosecond |
|---|---|
| 0000 0000 0000 0000 0000 0000 0000 0000 | Message transmitted on the UTC second |
| 0000 0000 0000 0000 0000 0000 0000 0001 | Message transmitted on the UTC second plus *INCR* |
| … | … |
| 1111 1111 1111 1111 1111 1111 1111 1111 | Message transmitted on the UTC second plus (1- *INCR*) |

Notes:

1. This data item, in conjunction with FRN 18 (Time of Message Reception) can be used to derive a range to target that is independent of the ADS-B-derived range. This can be used to provide a degree of added surveillance integrity
2. FRN #4 (Time of Applicability) defines the whole second part to which this fractional second measurement applies
3. This data item will have to be derived within the GBT based on protocols specific to a particular ADS-B data link.

# APPENDIX A TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 033 (13 JAN 2003)

## FRN 18: Time of Message Reception

Definition: The time at which the ADS-B message was received at the GBT expressed as fractional seconds from the UTC second.

.

Structure: Fixed four byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| Msb | --Time of Message Reception-- | | | | | | | | | | | | | | |
| Byte 3 | | | | | | | | Byte 4 | | | | | | | |
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Time of Message Reception-- | | | | | | | | | | | | | | | Lsb |

Encoding:

Bits 32/1 Time of message reception encoded as nanoseconds elapsed after the UTC 1 second time mark.

TIME OF MESSAGE RECEPTION

| **Time of Message Reception bits**<br>Msb Lsb | **Meaning**<br>$INCR = Lsb = \frac{1 \text{ sec}}{2^{32}} = 0.2328$ nanosecond |
|---|---|
| 0000 0000 0000 0000 0000 0000 0000 0000 | Message received on the UTC second |
| 0000 0000 0000 0000 0000 0000 0000 0001 | Message received on the UTC second plus *INCR* |
| … | … |
| 1111 1111 1111 1111 1111 1111 1111 1111 | Message received on the UTC second plus (1- *INCR*) |

Notes:

1. This data item, in conjunction with FRN 17 (Time of Message Transmission) can be used to derive a range to target that is independent of the ADS-B-derived range. Additionally, when a given target is in coverage of multiple networked GBTs, this data item can be used to perform a time difference of arrival localization of the target. This is also independent of the ADS-B reported postion. These techniques can be used to provide a degree of added surveillance integrity.
2. FRN #4 (Time of Applicability) defines the whole second part to which this fractional second measurement applies
3. This data item will have to be derived within the GBT based on protocols specific to a particular ADS-B data link.

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

**B.1 General**

The format for target reports is based on the ASTERIX message standard adopted by Eurocontrol for surveillance data exchange. For background information on the ASTERIX structure and encoding see the document entitled, "Eurocontrol Standard Document for Surveillance Data Exchange, Part 1, ASTERIX," SUR.ET1.ST05.2000-STD-01-01, November 1997. This document is available at http://www.eurocontrol.be/projects/eatchip/asterix.

A User Application Profile (UAP) is a mechanism for assigning Data Item to Data Fields of ASTERIX messages and containing all necessary information which needs to be standardized for the successful encoding and decoding of the messages. An ASTERIX Data Category (CAT) is defined by a set of Data Items that could be included in valid messages of that category. The ASTERIX Data Category for periodic Status reports from the GBT has been given the assignment "023"[7]. This value, which is normally the first Data Item in a Data Block, is also interpreted to be the BSDU ID field (Section 3.2).

The Field Reference Number (FRN) establishes the order of the items in the FSPEC, and along with the Category code serves to uniquely identify each data item. In order to maximize compatibility with future versions of this category, these data items will retain the same FRN and order in the FSPEC while new items may be added onto the end of the FSPEC.

[7] This category number is being established for use within the NAS; this category definition has not been approved by Eurocontrol

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## B.2 Target Report Construction Example

**Time** ⟶

| FSPEC | FRN 1 Version Number | FRN 2 Data Source ID | FRN 3 Time of Status Report | FRN 4 GBT Status | FRN 5 Internal GPS Integrity and Accuracy Params | FRN 6 Latitude/Longitude | FRN 7 ADS-B messages Discarded | FRN 8 TIS-B reports Discarded | FRN 9 Uplink Data Blocks Discarded |
|---|---|---|---|---|---|---|---|---|---|

| F1 | F2 | F3 | F4 | F5 | F6 | F7 | FX | F8 | F9 | F10 | F11 | F12 | F13 | F14 | FX |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

3. *Within each Data Item, Byte 1 is transmitted first*
4. *"FX" is the Field Extension bit. A ONE in this bit indicates the field extends into the next byte.*

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## B.3 User Application Profile and Construction for Cat 023 Target Reports

Table B-2. Cat 023 (V 1) User Application Profile and Construction

| FRN | Data Item | Length in Bytes (when present) |
|---|---|---|
| 1 | Version Number | 1 |
| 2 | Data Source Identifier | 2 |
| 3 | Time of Status Report | 3 |
| 4 | GBT Status | 1 |
| 5 | Internal GPS Integrity and Accuracy Paramters | 2 |
| 6 | Latitude/Longitude | 6 |
| 7 | ADS-B Messages Discarded | 2 |
| 8 | TIS-B Reports Discarded | 2 |
| 9 | Uplink Data Blocks Discarded | 2 |
| | | |

*Note: Systems receiving Cat 023 reports must parse the FSPEC for proper decoding since some Data Items are optional in any given report.*

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

### B.4 Format and Encoding of Cat 023 (V 1.0) Data Items

## FRN 1: Version Number

Definition: Version of this Cat 033 format**.**
Structure: One byte fixed length data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Spare bit | Spare bit | Version Status | Msb — Version Number — Lsb | | | | |

Encoding:

Bits 8/7: Spare bits always set to ZERO
Bit 6: ZERO=Version for operational use; ONE=Version is for experimental use only
Bits 5/1: Cat 023 version number encoded as binary numeral in the range of 1 to 31 (Value of ZERO represents "unknown" version regardless of "Version Status".

Category 023 messages conforming to this document shall be encoded with the value ONE in the Version Number field (Bits 5/1).

Notes:

2. This provides an upgrade path for evolution of this Category without incrementing the Category number modulo 32.

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 2: Data Source Identifier

Definition: Identification of the system supplying surveillance data**.**
Structure: Two byte fixed length data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Msb | | | | | | | Lsb | Msb | | | | | | | Lsb |
| --SAC-- | | | | | | | | --SIC-- | | | | | | | |

Encoding:

bits 16/9: (SAC)System Area Code (0 → 255)
bits 8/1: (SIC)System Identification Code (0 → 255)

Notes:

3. The SAC is used to identify regions of the world.
4. The SIC is used to identify individual systems (e.g., ADS-B receiver or TIS-B transmitter, radar/beacon sensor, multisensor fusion processor, etc)

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 3: Time Of Status Report

Definition: Time at which the Status report information was recorded
Structure: Three byte fixed data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| Msb --Time of Status Report-- | | | | | | | |

| Byte 2 | | | | | | | | Byte 3 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Time of Status Report-- | | | | | | | | | | | | | | | Lsb |

Encoding:

| | |
|---|---|
| Bits 24/8 | whole seconds elapsed since UTC midnight binary encoded |
| Bits 7/1 | fractional seconds elapsed since UTC midnight binary encoded |

Notes:

3. The time of the day value is reset to 0 at every midnight. The time of the day is specified in UTC.
4. The Lsb represents 1/128 of a second

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 4: GBT Status

Definition: Reports the status of the GBT functional elements
Structure: One byte fixed length data item

| Byte 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| GBT Timing Status | Receiver Status | Transmitter Status | Spare bit | Msb GBT State Lsb | | | Spare bit |

Encoding:

Bit 8: GBT Timing Status: ONE = UTC coupled; ZERO = non-UTC coupled (i.e., coasting)

Bit 7: Receiver Status: ONE = Normal; ZERO = Alarm condition (i.e., GBT-detected fault)

Bit 6: Transmitter Status: ONE = Normal; ZERO = Alarm condition (i.e., GBT-detected fault)

Bit 5: Spare bit always set to ZERO

Bits 4/3 GBT State: (see table below)

| **GBT State bits** Msb Lsb | **Meaning** |
|---|---|
| 000 | Off Line State |
| 001 | On Line State |
| 010 | (Reserved) |
| 011 | (Reserved) |
| 100 | (Reserved) |
| 101 | (Reserved) |
| 110 | (Reserved) |
| 111 | (Reserved) |

Bit 1: Spare bit always set to ZERO.

Notes:

1. Only two of the GBT states are reportable in a Status report since all other states result in no data output on the Ground Interface.

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 5: Internal GPS Integrity and Accuracy Parameters (Page 1 of 2)

Definition: This data item conveys the accuracy and integrity parameters reported by the GBT internal GPS timing source

Structure: Fixed two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| sb | Msb --NIC-- Lsb | | | | Spare bits | | | Msb --NACp-- Lsb | | | | | sb | sb | sb |

Encoding:

Bit 16: Spare bit always set to ZERO.

Bits 15/12: Navigation Integrity Categories (NIC)

The Navigation Integrity Category (NIC) is reported so that surveillance applications may determine whether the reported position has an acceptable level of integrity for the intended use. The value of the NIC parameter specifies an integrity containment radius, $R_C$..

| **NIC bits** Msb Lsb | **Horizontal and Vertical Containment Bounds** | **Comment** |
|---|---|---|
| 0000 | $R_C \geq 37.04$ km (20 NM) | Unknown Integrity |
| 0001 | $R_C < 37.04$ km (20 NM) | RNP-10 containment radius |
| 0010 | $R_C < 14.816$ km (8 NM) | RNP-4 containment radius |
| 0011 | $R_C < 7.408$ km (4 NM) | RNP-2 containment radius |
| 0100 | $R_C < 3.704$ km (2 NM) | RNP-1 containment radius |
| 0101 | $R_C < 1852$ m (1 NM) | RNP-0.5 containment radius |
| 0110 | $R_C < 1111.2$ m (0.6 NM) | RNP-0.3 containment radius |
| 0111 | $R_C < 370.4$ m (0.2 NM) | RNP-0.1 containment radius |
| 1000 | $R_C < 185.2$ m (0.1 NM) | RNP-0.05 containment radius |
| 1001 | $R_C < 75$ m and VPL < 112m | e.g., WAAS HPL, VPL |
| 1010 | $R_C < 25$ m and VPL < 37.5m | e.g., WAAS HPL, VPL |
| 1011 | $R_C < 7.5$ m and VPL < 11m | e.g., LAAS HPL, VPL |

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 5: Integrity and Accuracy Parameters (Page 2 of 2)

Bits 8/4: Navigation Accuracy Categories for Position (NACp)

The Navigation Accuracy Category for Position (NACp) is reported so that surveillance applications may determine whether the reported position has an acceptable level of accuracy for the intended use. The Estimated Position Uncertainty (EPU) is a 95% accuracy bound on horizontal position. EPU is defined as the radius of a circle, centered on the reported position, such that the probability of the actual position being outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure of Merit). Likewise, Vertical Estimated Position Uncertainty (VEPU) is a 95% accuracy limit on the vertical position. VEPU is defined as a vertical position limit, such that the probability of the actual vertical position differing from the reported vertical position by more than that limit is 0.05. When reported by a GPS or GNSS system, VEPU is commonly called VFOM (Vertical Figure of Merit).

| **NACp Bits** | | **95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU)** | **Comment** |
|---|---|---|---|
| Bit 8 | Bits 7-4 Msb Lsb | | |
| 0 | xxxx | NACp not available in this reporting interval | |
| 1 | 0000 | EPU ≥ 18.52 km (10 NM) | |
| 1 | 0001 | EPU < 18.52 km (10 NM) | RNP-10 accuracy |
| 1 | 0010 | EPU < 7.408 km (4 NM) | RNP-4 accuracy |
| 1 | 0011 | EPU < 3.704 km (2 NM) | RNP-2 accuracy |
| 1 | 0100 | EPU < 1852 m (1NM) | RNP-1 accuracy |
| 1 | 0101 | EPU < 926 m (0.5 NM) | RNP-0.5 accuracy |
| 1 | 0110 | EPU <555.6 m ( 0.3 NM) | RNP-0.3 accuracy |
| 1 | 0111 | EPU < 185.2 m (0.1 NM) | RNP-0.1 accuracy |
| 1 | 1000 | EPU <92.6 m (0.05 NM) | e.g., GPS (with SA) |
| 1 | 1001 | EPU < 30 m and VEPU < 45 m | e.g., GPS (SA off) |
| 1 | 1010 | EPU < 10 m and VEPU < 15 m | e.g., WAAS |
| 1 | 1011 | EPU < 3 m and VEPU < 4 m | e.g., LAAS |

Bits 3/1: Spare bits always set to ZERO.

# APPENDIX B TO GBT SYSTEM SPECIFICATION
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## FRN 6: Latitude and Longitude (page 1 of 2)

Definition: GBT latitude and longitude position as determined from the GBT internal GPS sensor.
Structure: Fixed 6 byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 |
| Msb | --Latitude-- | | | | | | | | | | | | | | |
| Byte 3 | | | | | | | | Byte 4 | | | | | | | |
| 32 | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 |
| --Latitude-- | | | | | | | Lsb | Msb | --Longitude-- | | | | | | |
| Byte 5 | | | | | | | | Byte 6 | | | | | | | |
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| --Longitude-- | | | | | | | | | | | | | | | Lsb |

Encoding:

Bits 48/1: Latitude and Longitude

LATITUDE AND LONGITUDE

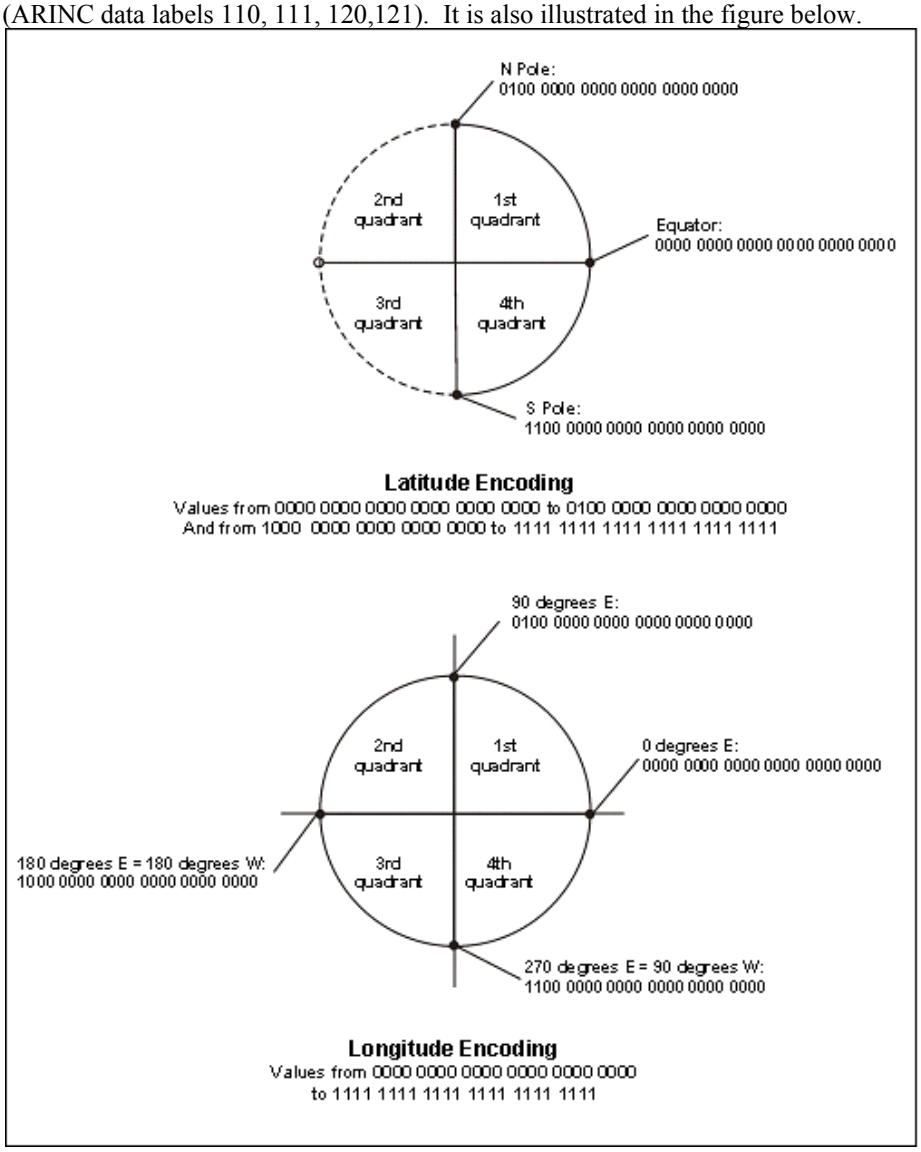
| **Quadrant** | **Latitude or Longitude bits** | **Meaning** $INCR = Lsb = \frac{360}{2^{24}} = 0.00002146\ ^\circ$ | |
|---|---|---|---|
| | Msb Lsb | **Latitude** | **Longitude** |
| 1st quadrant | 0000 0000 0000 0000 0000 0000 | ZERO degrees (Equator) | ZERO degrees (Prime Meridian) |
| | 0000 0000 0000 0000 0000 0001 | *INCR* degrees North | *INCR* degrees East |
| | … | … | … |
| | 0011 1111 1111 1111 1111 1111 | (90-*INCR*) degrees North | (90-*INCR*) degrees East |
| 2nd quadrant | 0100 0000 0000 0000 0000 0000 | 90 degrees (North Pole) | 90 degrees East |
| | 0100 0000 0000 0000 0000 0001 | <Illegal Values> | (90+*INCR*) degrees East |
| | … | <Illegal Values> | … |
| | 0111 1111 1111 1111 1111 1111 | <Illegal Value> | (180-*INCR*) degrees East |
| 3rd quadrant | 1000 0000 0000 0000 0000 0000 | <Illegal Value> | 180 degrees East or West |
| | 1000 0000 0000 0000 0000 0001 | <Illegal Value> | (180-*INCR*) degrees West |
| | … | <Illegal Values> | … |
| | 1011 1111 1111 1111 1111 1111 | <Illegal Values> | (90-INCR) degrees West |
| 4th quadrant | 1100 0000 0000 0000 0000 0000 | -90 degrees (South Pole) | 90 degrees West |
| | 1100 0000 0000 0000 0000 0001 | (90-*INCR*) degrees Sourth | (90-*INCR*) degrees West |
| | … | … | … |
| | 1111 1111 1111 1111 1111 1111 | *INCR* degrees South | *INCR* degrees West |

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 6: Latitude and Longitude (page 2 of 2)

Notes:

2. This encoding is consistent with that of GPS/GNSS avionics providing Latitude/Longitude inputs to ADS-B (ARINC data labels 110, 111, 120,121). It is also illustrated in the figure below.



# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 7: ADS-B Messages Discarded

Definition: A count of ADS-B messages that were discarded this Status reporting interval.
Structure: Fixed two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Msb | | | | | | | | | | | | | | | Lsb |
| --Discard Count-- | | | | | | | | | | | | | | | |

Encoding:

Bit 16/1 Count of discarded ADS-B messages this Status reporting interval binary encoded

# APPENDIX B TO GBT SYSTEM SPECIFICATION
# ASTERIX CAT 023 (13 JAN 2003)

## FRN 8: TIS-B Reports Discarded

Definition: A count of TIS-B reports that were discarded this Status reporting interval.
Structure: Fixed two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Msb | | | | | | | | | | | | | | | Lsb |
| --Discard Count-- | | | | | | | | | | | | | | | |

Encoding:

Bit 16/1 Count of discarded TIS-B reports this Status reporting interval binary encoded

## FRN 9: Uplink Data Blocks Discarded

Definition: A count of Uplink Data Blocks that were discarded this Status reporting interval.
Structure: Fixed two byte data item

| Byte 1 | | | | | | | | Byte 2 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
| Msb | | | | | | | | | | | | | | | Lsb |
| --Discard Count-- | | | | | | | | | | | | | | | |

Encoding:

Bit 16/1 Count of discarded Uplink Data Blocks this Status reporting interval binary encoded